CHURCH RESPONSES TO THE DEVELOPMENT AND USE OF NUCLEAR ENERGY TECHNOLOGY

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ABSTRACT

One of the most consistent criticisms launched against church involvement in the nuclear energy debate, is that the issues are far too complex for the minds of non-nuclear experts. Partially in response to this charge, and partially to clarify what the issues are, the First Chapter of this thesis weighs the major arguments put forth by the various sides of the atomic power debate. The major conclusion reached is that ultimately, the debate is about values - specifically the relationship of man, God, and the creation.

The ethical continuum involved seems to be defined at one end by the belief that man stands apart from his environment, is free to manipulate it at will, and that any problem occurring in the environment can eventually be solved with human intelligence and scientific skill. At the other end of the continuum is the conviction that all things existing in the biosphere are related to everything else, and that every gain - particularly if of a technological nature - is achieved at some cost to the total environmental balance. These two perspectives, the middle ground between them, and the overall ecological context surrounding industrial issues, are explored in Chapter Two.

The thesis is in basic agreement with those who warn of a deepening ecological crisis. After reviewing the present levels of over-population and food scarcity, environmental pollution, diminution of wildlife habitat, and depletion of natural resources, the deduction made is that the cause of our present predicament rests with human shortsightedness and/or irresponsible arrogance toward the natural environment. The second half of Chapter Two explores several ideological/

ideological sources of the ecological crisis, and argues strongly in favour of a cultural re-examination of our antiquated environmental principles. Numerous examples of past unenlightened technological decisions made without ethical assessment regarding the biospheric organism, point to the importance of theological input into the present nuclear energy debate. As Chapter One stresses the ethical considerations of the issues surrounding nuclear energy, Chapter Two demonstrates the disastrous consequences of any technological decisions made without attention to ethical assessment.

The application of ethical assessment to nuclear technology is the theme of the Third Chapter. Beginning with a survey of various church responses to the development and use of nuclear energy technology, the chapter focuses on the discovery by the churches of their legitimate and important place in the debate. Since the mid-1970s, such major church groups as the World Council of Churches (WCC), the National Council of Churches (NCC), the British Council of Churches (BCC), the French Protestant Federation (FPF), the Evangelical Church in German (EKD), and several British church organisations have cautiously entered into the debate. Motivated by the increasing awareness of reactor safety deficiencies, the perceived link between nuclear energy technology and nuclear weapons, the ecological hazards of radioactive waste, and the attendant long range commitments of nuclear technology, these church groups have persistently attempted to air all of the manifold complexities of nuclear power. In so doing they have independently reached near unanimity in calling for a reassessment of the ultimate worth and desirability of nuclear power. As of this writing, the overwhelming consensus among these church groups concerned with the dilemmas of nuclear energy, is that the hazards of nuclear technology have not been/

been adequately dealt with at either the industrial or national levels to justify further expansion of the nuclear power programme.

The second part of Chapter Three explores the specific ethical issues defined by the church groups in their critique of nuclear power technology. The hazards that have been given top priority by the concerned churches include the dangers of high and low level nuclear radiation leakage to both human and animal health, the risks of proliferation and nuclear terrorism, and the possible necessity of creating a global police state to ensure the safe development and use of a world-wide nuclear programme. In the face of several challenging arguments which claim that safer, non-nuclear alternatives can be developed to solve the world's energy requirements, the churches have concluded that it would be immoral to simply accept the hazards of nuclear power without first investigating the less dangerous energy options.

A major claim of this thesis is that the pronouncements regarding nuclear energy by the concerned churches are at least in part a practical expression of an extensive theological movement sweeping through Christian doctrine today. Simply put, this movement is the development of a theology of ecology, and has had its popular expression in the works of such Christian environmentalists as Joseph Sittler, Paul Santmire, John Cobb, Paul Lutz, Frederick Elder, Richard Baer, and John MacQuarrie. The ethic of universality and ecological wholeness which is emerging from this modern school of Christian environmentalism, has been referred to again and again by the concerned churches in their deliberations concerning nuclear energy. In their appraisal of the stated need in the West for nuclear energy technologies, the churches have questioned the current growth rate policies of the western nations/

nations, which are predicated on ever-expanding production and consumption of goods and services. Also, it has often been expressed by the churches that the goal of any energy policy should be the development of a world community based on the present and future best interests of all people and nations, and on the absolute respect of the natural world and its ability to support life. From the perspective of the concerned churches, then, the dilemmas posed by nuclear energy technology have to do with nothing less than the whole of creaturely life - human and non-human, social and environmental. These are precisely the same dimensions currently being explored by the emerging school of Christian environmentalism. Surely the environmental crisis today testifies to the necessity of such an ecological theology, and the manifold hazards inherent in nuclear energy technology warrant decision making processes that go beyond mere technological and political concerns.

In short, this thesis claims that there are important ethical considerations surrounding the continued development and use of nuclear energy technologies, that various Christian church groups have defined and studied these considerations in detail, and that their pronouncements regarding these considerations are part of a broad environmental ethic which is of tremendous importance for the future well-being of our planet.

CHURCH RESPONSES TO THE DEVELOPMENT AND USE OF NUCLEAR ENERGY TECHNOLOGY, 1960-1980

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DECLARATION

I hereby declare that the following thesis is based on the results of research carried out by myself, that it is my own composition and that it has not previously been presented for a higher degree. The research was carried out at the University of St. Andrews under the supervision of Professor James A. Whyte.

....

CERTIFICATE

I certify that Jack Edward MacSlarrow has fulfilled the conditions of the resolution of the University Court, 1970, No. 3, and that he is qualified to submit this thesis in application for the Degree of Master of Philosophy.

....

Professor James A. Whyte,
St. Mary's College,
University of St. Andrews.

DEDICATION

To Jasper and Heather: may you never lose your sense of universal oneness.

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This thesis has had a long history. Its roots go back to the mid-1960's when my first explorations into the subject of nuclear power were aided by the keen intellect and guidance of Rt. Rev. John Leffler, Dean of St. Mark's Cathedral, Seattle. My interest in the subject grew as I participated in several conferences on the ethical appraisals of nuclear energy, and culminated with my work done at St. Mary's College, 1979-1981.

Of all those who assisted along the way, I am particularly grateful for the wisdom, direction, and patient understanding of my adviser, Rev. James Whyte, St. Mary's; for the incalculable editing help of my wife, Dorothy; and for the encouragement and guidance given by John Francis, Scottish Development Board, and by Rev. Terry Anderson, Vancouver School of Theology.

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Finally, very sincere gratitude must be given to Rev. George Morrison, whose sparkling enthusiasm made the whole thing possible.

CONTENTS

It is probably true quite generally that in the history of human thinking the most fruitful developments frequently take place at those points where two different lines of thought meet. These lines may have their roots in quite different parts of human culture, in different times or different cultural environments or different religious traditions: hence if they actually meet, that is, if they are at least so much related to each other that a real interaction can take place, then one may hope that new and interesting developments may follow.

WERNER HEISENBERG

INTRODUCTION

Science and Religion both had their origins in primitive attempts to get in touch with whatever forces control the course of nature and the fortunes of men. Our Science is the lineal descendent of the magic which treated these forces as impersonal - to be controlled by discovering the appropriate formula or ritual practice. Our Religion is from the attempts to approach these forces as personal deities or spirits - to gain the favour of those disposed to be beneficent and to placate or propitiate those who were not. Science and Religion, the profane and the profound forces of Western society, have recently reached an area that requires compromise and united action. That area is the realm of ecological concerns. The most apparent manifestation of this religio-scientific, ecological dynamic is the issue of nuclear energy, as the technical decisions made in this domain involve unique considerations of human value and the future structure of society. At issue are economic, social, environmental, and political concerns, all interrelated in the complex web of advanced energy technology. At the fore of this technology stands the much celebrated and much condemned Fast Breeder Reactor (FBR). Celebrated as the cleanest, safest, and cheapest way of producing the world's energy needs for the next couple of centuries, the FBR's immediate development and widespread use are currently being urged by atomic energy authorities in Britain, France, West Germany, Canada, and the United States. Condemned as one of the final steps toward nuclear catastrophe, the FBR stands as the central issue in a nuclear power moratorium now called for by environmental groups the world over. On such a complex issue, where even the scientific community appears to be divided, Christian church organisations in the technically advanced nations of the Western/

Western hemisphere - notably the British Council of Churches (BCC), the Church of Scotland, the National Council of Churches (NCC) in the United States, the French Protestant Federation (FPF), and the Evangelische Kirche in Deutschland (EKD) - have, together with the World Council of Churches (WCC), cautiously entered into the debate.

These 'concerned' church groups have had to deal with the unique theological dimensions of advanced energy technology, as well as the fundamental realisation that as humanity's scientific and technical capabilities have increased, the scale of success and failure have become more pronounced, and the attending social and environmental risks have been dramatically increased. This has prompted the churches to address fundamental questions concerning the nature of technological development itself, along with the more immediate issues concerning the risks of a nuclear powered economy. 'How far do recent scientific developments oblige us to reaccess the whole scientific revolution from the seventeenth century, out of which the harnessing of the powers of the universe which dominate our thoughts today has come?',[1] asked the WCC in 1975. While certainly not new, this mood to levy some kind of ethical assessment of science, and of its technological application, seems to have come into clearer focus for the concerned churches over the nuclear energy issue. While none of the church groups has gone on record as declaring that a further development of nuclear technology would be a betrayal of God or humanity, the question 'Is technological man playing God?' has been independently raised by them all.

1. John Francis and Paul Abrecht, eds., <u>Facing Up to Nuclear Power</u> (St. Andrews Press, Edinburgh, 1976), p. 198.

Church involvement in the nuclear energy debate appears to be a product of an underlying assumption that contains two aspects: that technological development is not necessarily conducive to the growth and health of humanity, or the natural world; and that scientific methodology is not equipped to yield all knowledge or solve all problems of man and society. Implicit in much of the church literature on the energy subject is the acknowledgement of a basic flaw within the scientific method itself. This flaw stems from the undeniable fact that the number of rational hypotheses that can explain any given phenomenon is infinite. Therefore, all of the hypotheses can never be tested, which means that the results of any scientific experiment are always inconclusive. The entire scientific method, therefore, is doomed to fall short of its goal of establishing proven knowledge. Scientific truth, then, can never be said to be absolute dogma, good for all eternity, but is always restricted to be a temporal entity - new and changing explanations of old facts. Consequently, instead of selecting one truth from the multitude of hypotheses, scientific rationalism increases the multitude - leading mankind, and any system of philosophy that aligns itself with such rationalism, from single, absolute truths to multiple, indeterminate, relative ones. It is with this ethical vacuum that church groups are concerning themselves.

While not yet openly hostile, various sectors of the scientific-technological world are definitely indicating an irritation with the theological involvement in what they consider to be exclusively technical territory. Here in Britain, for example, Justice Parker's report to the Windscale Inquiry almost totally ignored the BCC's contribution to the debate, and contained the moral considerations

considerations of the Windscale development under the heading 'Public Hostility'. Lord Parker also disregarded the BCC's plea for a hierarchy of values, contending that 'It is not for me to attempt to reach a conclusion on the morality of the situation.'[2] Subsequent articles published in the United Kingdom Atomic Energy Authority's (UKAEA) monthly bulletin Atom have misrepresented the BCC's position and have made it to appear anti-nuclear.[3] Additionally, key figures in Britain's nuclear development camp have successively characterised any ethical resistance to technological development as 'irrational reaction, stemming from deep emotional conviction rather than any dispassionate analysis of the problems and the practical options for dealing with them',[4] as 'uninformed and misleading attacks'[5] on the nuclear industry, as 'emotive',[6] as 'arguing on a conceptual basis',[7] and as 'hasty ... without a clear elucidation of the basic principles'.[8] Such sensitivity to ethical involvement is reminiscent of an earlier age when it was the scientists who were asking the embarrassing questions of the theological worldview, and the/

2. David Gosling, The Nuclear Debate in the U.K. and the Contribution of the British Council of Churches (British Council of Churches, London, 1979), p. 5.

3. Atom (UKAEA), No. 259, May 1978, p. 136; No. 264, October 1978, p. 278.

4. Atom (UKAEA), No. 234, April 1976, p. 2.

5. Atom (UKAEA), No. 239, September 1976, p. 3.

6. J.S. Forrest, ed., The Breeder Reactor (Scottish Academic Press, Edinburgh, 1977), p. 2.

7. Ibid., p. 83.

8. Crusade, August 1977, p. 13.

the theologians were responding with dogmatism.

What appears to be at issue in the nuclear energy debate is more than just the moral considerations of nuclear energy. Concerned church groups are asking important questions regarding the relationship of God, humanity, and nature; and scientific technologists are defensively responding with a dogma that adheres to a mechanistic cosmology. This cosmology was developed in the era of Newtonian Physics in which the universe was seen in terms of deterministic laws, man was perceived as being detached from objective nature, and the assumption that Science alone could solve all mankind's problems was made. At stake in the current energy debate, then, is this way of looking at the world - this a priori concept of the relationship between man and nature. The alternative a priori concept that threatens to replace this classical one, is one in which everything - the activity of God, the life of man, and the processes of nature - is intimately related to everything else. In this worldview, nothing would be perceived as existing in isolation. The identity of a thing would be contingent upon its relationships with other things. All forms of life would be seen as being interrelated to each other and to the non-living environment.

Ironically, there have been at least two major accomplishments in the scientific realm this century which have given impetus to this concept of ecological unity - the composition of matter in subatomic physics, and the view of Earth as seen from the perspective of the Moon. The discovery of subatomic physics was the result of two scientific breakthroughs; relativity theory and quantum mechanics. In the quantum-relativistic model of subatomic physics, the Newtonian concept of matter as that which is constituted of elementary, indestructible, and unchangeable units, breaks down. In its place/

place is a universe which appears as a dynamic web of inseparable energy patterns; - a universe where 'the properties of a particle can only be understood in terms of its activity - of its interaction with the surrounding environment ... the particle, therefore, cannot be seen as an isolated entity, but has to be understood as an integrated part of the whole'.[9] The extrapolation of this revelation of inner space into the reaches of outer space was carried out by the Apollo 8 spacecraft, as it and its three human astronauts circled the Moon on Christmas Eve, 1968. From this vantage point of one quarter of a million miles away, the Earth was viewed holistically as a large terrestrial spaceship, set in the black void of space. Spaceship Earth was clearly seen by human eyes to have finite spatial limits, and was recognised for what it is - a functionally closed system. Mankind was suddenly confronted with the established fact that the Earth is a finite, closed ecosystem in which all life is inter-related.

In Stanley Kubrick's film '2001 - A Space Odyssey' - a classic epic journey, or quest, to find truth in a modern milieu - a proto-man hurls a bone-club into the air after vanquishing the enemy. The club is transformed into a whirling spaceship deep in space. This incredible leap in technological development occurred without a corresponding growth in ethics to hold the technology in check. The balance is restored at the end of the film, when man is spiritually reborn only after subduing a runaway computerised world. The lesson is clear: of itself, technology is neither good/

9. Fritjof Capra, The Tao of Physics (Fontana Books, Bungay, 1976), p. 85.

good nor evil. It is not connected in any real way with matters of the spirit or of the heart. What gives it ethical power is the way in which it is allowed to be developed and used. The unique ethical dilemmas posed by advanced energy technology today, testify to the dawning awareness that the classic theological solutions simply do not work any longer. This appears to be a basic understanding of the concerned church groups, and it has forced them into a more mature theological worldview.

Concern for an unhealthy biosphere and frustration over the undesirable effects of a valuefree technology have precipitated a modern search for meaning. The ethical and cosmological challenges posed by advanced nuclear energy technology must be faced in this search. It is my contention that concerned church groups, recently armed with a dynamic reinterpretation of the concept of divine creation, a holistic view of the Earth as a spaceship, and a scientific description of the world founded on the principle of interrelatedness, are, perhaps unconsciously, taking the first practical steps toward replacing the classical, mechanistic a priori concept of the world with a worldview based more on ecological principles. It is hoped this thesis will demonstrate that the theological principles being applied by the churches to the nuclear energy debate, are making a contribution to the establishment of this new worldview.

CHAPTER I

DILEMMAS OF NUCLEAR ENERGY

ECONOMICS OF ENERGY

One of the main issues, if not the principal one, in the nuclear energy debate is that of Economics. The fundamental justification for nuclear power is that it produces cheaper electricity than alternative energy sources. Proponents assert that in addition to its lower cost, nuclear energy is an essential component of energy independence for the technically advanced western nations. The relevance of this argument in the wake of the oil embargo imposed by the OPEC nations following the Yom Kippur War in 1973, plus the subsequent doubling and redoubling of oil prices in the mid-1970's, is obvious. Critics of nuclear power, however, question its reputed economic benefits by pointing to escalating costs of nuclear construction and fuel, poor reactor performance, hidden subsidies, and the high cost of decommissioning. Clearly, both sides of the issue are basing their logic on widely divergent assumptions regarding the uncertainties of future energy demand, the relationship of energy consumation with economic growth, the predicted rising costs of energy, the availability of uranium and fossil fuels, and the assessment of developing nuclear and alternative sources of energy.

In order to put nuclear energy in a proper perspective, each of these fundamental issues will be analysed in this chapter. Additionally, the economics of nuclear power as compared with coal, the closest competitor, and with other alternative energy sources will be considered.

Predictions of Energy Use/

Predictions of Energy Use

Few things, it appears, cause more disagreement among energy planners than energy forecasts. For example, during the public hearings on nuclear energy organised by the British Council of Churches in December 1976, Mr. Robert Belgrave, Policy Advisor to the Board of British Petroleum, and Dr. Peter Chapman, Director of the Energy Research Group at the Open University, differed by fifty years in their estimates as to the time scale in which current energy demands will double. Mr. Belgrave, arguing largely on the basis of anticipated 'historical' economic growth patterns during the last quarter of this century, concluded that 'energy demand in industrialised countries is likely to be at least double the present level by the end of the century'.[1] For the United Kingdom, this would mean an energy requirement of between 600 and 700 million tons of coal equivalent (MTCE) by the year 2000. Dr. Chapman, on the other hand, asserting that future energy needs will be held in check by more efficient fuel utilization, likely shifts in the industrial sector, and approaching saturation in domestic energy consumption, concluded that Britain's energy requirement will stabilize at '400 to 450 MTCE per year by 2000, and 600 to 700 MTCE/year by 2050'.[2]

A similar dramatic variance as to future energy projections was established by a special meeting held at the University of Strathclyde in May 1977 on the Breeder Reactor, and by Gerald Leach in his Energy Projections published in 1979. The Strathclyde/

1. Hugh Montefiore and David Gosling, ed., Nuclear Crisis: A Question of Breeding (Prism Press, London, 1977), p. 10.

2. Ibid., p. 12.

Strathclyde conclusions, based on the research of D.R. Berridge, of the South of Scotland Electricity Board, and K.R. Vernon, of the North of Scotland Hydro-Electric Board, establish a minimum requirement of at least 500 MTCE by the year 2000.[3] Gerald Leach, however, using a forecast model that projects for high and low energy consumption for the last quarter of the century, concludes that Britain's energy requirement for the year 2000 will be between 325 and 350 MTCE.[4]

Energy demand, apparently, is an uncertain variable. The fact that it is influenced by market forces, social developments, and public policies only lends to its illusiveness. The paradox of energy projections - that if the future is unconstrained, so that there are real political and economic choices to be made, then it is unknowable and unforecastable - was underscored by Peter Chapman in his testimony before the Parliamentary Liaison Group for Alternative Energy Strategies on November 22, 1978. He concluded that 'the forecast is no more than an elaborate restatement of the inputs: a way of pushing for one particular view of the future'.[5] Certainly, the traditional methods used by the Government and other official agencies to predict future energy needs by extrapolating from historic trends have been called into question by recent studies/

3. D.R. Berridge and K.R. Vernon, 'The Breeder Reactor in Electricity Supply', in J.S. Forrest, ed., The Breeder Reactor (Scottish Academic Press, Edinburgh, 1977), p. 77.

4. Gerald Leach, et.al., A Low Energy Strategy for the United Kingdom (Science Reviews Ltd., London, 1979), p. 17.

5. Church of Scotland - 'Science, Religion, and Technology Project Broadsheet' (Edinburgh, December 1978), p. 1.

studies carried out in both Britain and the United States.[6] Additionally, the traditional positive correlation struck between energy demand the economic growth, and the presentation of this as absolute dogma - as in the Government's assumption that 'total world demand for energy in the year 2000 will depend primarily on the future rate of economic growth'[7] - have likewise been criticised as 'simple forms of materialistic philosophy'.[8] The counter argument runs that since predicted energy costs are generally pegged at only 5 to 10 percent of income, they cannot be a strong influence on income levels or economic growth rates.

Another factor disputed by energy experts on both sides of the nuclear power issue, is the effect that higher energy costs will have on future consumption patterns. Advocates of low growth projections argue that such costs will prevent the high rates of energy consumption, as has been witnessed in the past several decades, to continue. Certainly, there are problems associated with energy supply (discussed in the next section) which will result in higher energy costs to society. Low growth advocates maintain that these/

6. Comprehensive critiques of this type of energy projection are found in Amory Lovins, Soft Energy Paths: Toward a Durable Peace (Penguin Books, Middlesex, 1977), pp. 28-38; Gerald Leach, et.al., A Low Energy Strategy for the United Kingdom (Science Reviews, Ltd., London, 1979), pp. 10-19; R. Stobaugh and D. Yergin, Energy Future (Random House, New York, 1979); and Swedish Institute for the Future, Energy in Transition (S.I.F., Stockholm, 1977).

7. Department of Energy, Energy Policy: A Consultative Document (HMSO, London, 1978), p. 13.

8. Church of Scotland - op.cit., p. 1.

these costs will be reflected in market prices, governmental policies - which may lead to shortages and subsequent changes in methods of production - in the mix of goods produced, in personal habits and lifestyles, and in the design of buildings and transportation systems, all of which will eventually reduce the energy needed per unit of income. For example, Government regulations mandating improvements in the efficiency of new automobiles would result in automobiles that would be similar to that which well-informed buyers would demand if they had to pay a high cost of petroleum. This assumption, that energy buyers will seek to minimize their cost, is thus a major factor in several low growth energy projections,[9] yet has been virtually disregarded by the forecasts published by the Department of Energy and advocates of high consumption patterns.[10]

One other factor in the dispute seems to be the potential effects of conservation measures. Energy conservationists in the United Kingdom point to several minimum measures that could be saving as much as 40% of the present energy consumed. Measures such as freight by rail rather than by relatively inefficient trucks, use of modern building technologies to cut down heat loss, reduction of inefficient space heating, and financial incentives given to householders for home insulation are often mentioned as having a high potential for energy conservation. The Government appears to be divided against itself on/

9. See H. Daly, On Thinking about Future Energy Requirements (Louisiana State University, Baton Rouge, 1976); Amory Lovins, op.cit., pp. 66-72; and Gerald Leach, et.al., op.cit., pp. 10-11, and pp. 17-19.

10. See J.S. Forrest, op.cit., pp. 1-8, pp. 49-52, and pp. 77-83; and Department of Energy, op.cit., pp. 7-14.

on this issue as its public statement issued on November 9, 1978, which asserted that 'British Industry could cut its energy consumption by 30% through technological changes',[11] appears to contradict its attitude contained in Cmnd. 7101 which 'maintains a chorus of faint praises for conservation; it is not in their interests to support a policy which could cut back their plans for expansion'.[12]

Out of the divergent views of energy planners concerning future energy consumption, three future energy strategies, or paths, can be discerned. These paths are: the 'hard path', or high nuclear case, the 'soft path', or delayed nuclear case, and the 'hard-soft path', or mixed case.[13] The 'hard path' involves large scale, capital-intensive centralised technologies, depending on large amounts of nuclear fuel and coal to satisfy the energy requirement throughout the remainder of the century. In the long-term projection, fossil fuels would be phased out entirely, and fast breeder reactors, and possibly fusion reactors, would be relied on increasingly. This strategy assumes continued high energy consumption as extrapolated from historic patterns, the development of economical nuclear technologies, and a reduced 'demand elasticity'[14] - making interest in energy conservation relatively/

11. Department of Energy, Energy Conservation, Research, Development, And Demonstration. An Initial Strategy for Industry (HMSO, London, 1978), p. 18.

12. Church of Scotland, 'Church and Nation Committee Energy Policy', (Edinburgh, February 1979), p. 1.

13. See Gerald Leach, et.al., op.cit.; and Amory Lovins, op.cit.

14. Demand Elasticity is defined as the percentage by which demand is reduced when the unit price of an item increases by 1 percent. Demand Elasticity is, thus, a measure of the ease with which people can exist with less of the item.

relatively insignificant. In the 'soft path', decentralised, less capital-intensive technologies are emphasised, with conservation techniques such as co-generation, solar heating, and biomass being developed throughout the remainder of the century. Coal would be utilised as the predominant transitional fuel to a future dependence on solar and other renewable energy sources. This strategy assumes an immediate reduction in energy demand - a product of higher energy costs and conservation measures - and the development of economical alternative sources of energy. The final energy strategy is the 'hard-soft' or mixed path. Here the emphasis would be placed on various energy options, with most of the stress being placed on the immediate development of alternative energy technologies, such as solar, wind, wave, biomass, etc., rather than the development of advanced nuclear technology, such as the fast breeder reactor. Existing nuclear technology would be exploited and utilised along with coal reserves as the predominant sources of fuel for the remainder of the century. The determination of long-range policies would be delayed for several decades to properly assess what effects conservation measures and the development of renewable energy sources would have on energy demand. Advanced nuclear technology would be given low priority until such time as it is obvious that an unmanageable energy gap would be inevitable without it. Two neglected issues of the 'hard' and 'soft' strategies, which the 'hard-soft' path appears to factor into account, are regional variances in energy resources, and regional differences of compatibility with the variety of energy options.

One of the most definitive analyses of the 'hard-soft' energy strategy is the Energy Technology Assessment (ETA) model developed/

developed by Alan Manne.[15] The basic assumption made by the model is that at constant energy costs, income and energy use would grow at 3.5 percent per year for the remainder of the century, and at slightly lower rates thereafter. At higher energy costs, the level of employment and resource use would continue to grow at the same rates, energy demand would be reduced, and income would be lowered. The model uses combinations of electric energy, non-electric energy, and conservation techniques which would minimize projected differences between output and energy costs. Hence, the demand for energy in both of its forms is anticipated to vary negatively with its own price increases, and positively with increases of the other. The model also allows for a number of quantitative constraints to be imposed - such as limits on the expansion of new sources, gradual constraints applied for environmental and expansion problems (particularly in the case of coal), limits on the available amounts of oil, gas, and uranium, allowances for non-price-induced conservation, and limits on the rate at which energy-conserving capital can be employed.

A major conclusion reached by the ETA model is that energy costs will not be critical in determining the economic future. This appears to contradict a basic assumption of the 'hard path' energy strategy, and confirm the results of two major energy studies completed in 1979 by the International Institute for the Environment and Development,[16] and the Harvard Business School.[17] In addition, the ETA analysis indicates/

15. Alan Manne, 'The Energy Technology Assessment Model', Bell Journal of Economics, (Autumn 1976).

16. See Gerald Leach, et.al., op.cit.

17. See R. Stobaugh and D. Yergin, op.cit.,

indicates that the costs of delaying nuclear power would not be significant - reaching only 1 percent of annual GNP throughout the remainder of the century. The model demonstrates that Plutonium recycle can be delayed indefinitely, at essentially no economic cost, and that fast breeder reactors can be postponed several decades into the twenty-first century at costs that would reach less than 1 percent of annual GNP under the worst conditions. One feature of the ETA model, which is particularly important from the standpoint of policy making, is the assumption that an advanced technology will be available around 2020. This advanced technology could be in solar power, fusion reaction, coal production, some combination of these, or a combination of these plus the development of the breeder reactor. The prospects of such advanced technologies are discussed in the fourth section of this chapter.

A highly significant, yet virtually unknown quantity regarding the international application of any projected energy demand model, is the energy demand factor for the developing world. Although the less developed countries currently account for less than 10 percent of world energy consumption, their energy use growth rate is very high, and may reach as much as 20 percent of the world market by the year 2000.[18] The share of this growing demand which could be supplied economically by nuclear power is yet another matter of dispute. A 1974 estimate by the International Atomic Energy Agency concluded that more than half of the total energy supply of developing countries might have to come/

18. K.T. Thomas, 'Energy Options and the Role of Nuclear Energy in Asian Countries' in John Francis and Paul Abrecht, eds., Facing Up to Nuclear Power (St. Andrew Press, Edinburgh, 1976), p. 74.

come from nuclear power by the year 2000.[19] More recent estimates by the World Bank suggest a number of reasons to doubt such a high projection, such as a slowed demand growth due to higher prices, the potential for increased production of fossil fuels in the developing countries, and the fact that nuclear reactors of less than 600 megawatt (MW) capacity are not likely to be available.[20] This fact, that smaller reactors are not being manufactured, is particularly significant since large 1,000 MW power plants are not at all suited for countries with small aggregate demand and poorly developed electrical grids.[21] Advocates of the 'soft' and 'hard-soft' energy strategies maintain that if small reactors are manufactured especially for this market, the capital cost per kilowatt will increase significantly, eliminating any economic advantage that nuclear power might have had.

Despite these many unresolved issues of projected energy demands, and of the methods that could be used to satisfy such demands, the present reality of nuclear power must be addressed. In the United Kingdom, nuclear power plants accounted for about 5,000 MW of electric capacity, or about 10 percent of the total national electric capacity, in 1978.[22] Abroad, nuclear power totalled about 67,000 MW.

19. International Atomic Energy Agency, Bulletin, Vol. 16, No. 1/2, 1974.

20. These issues are carefully analysed in A.K.N. Reddy, The Technological Roots of India's Poverty (Institute of Science, Bangalore, 1976).

21. K.T. Thomas, op.cit., p. 84.

22. D.O.E., Energy Policy: A Consultative Document (HMSO, London, 1978), p. 45.

At the end of 1978, there were 197 known nuclear reactors operating around the world, with another 123 under construction and yet another 217 planned.[23] While there has been a substantial cutback in plans for nuclear power plants in the past two years, this reduction appears to be primarily the result of economic recession and reduced projections of electricity demand[24] rather than a rejection of the nuclear power option. In fact, the Department of Energy for the United Kingdom has recently predicted a 'steady build-up in nuclear power ordering in the second half of the 1980s and 1990s, and a maximum total installed nuclear capacity of around 40,000 MW by the end of the century.[25] In the United States, a similar prediction of nuclear power capacity for the year 2000 is currently in the 386,000 to 62,000 MW range.[26]

Supplies of Fossil Fuels

The most important factor in the cost of any energy option is the availability and cost of fuel supplies. Considerable disagreement exists among energy experts over the extent of uranium resources, the future costs and availability of coal, the time scale for the exhaustion of oil and gas, and the prospects for energy from/

23. Robert Jungk, The Nuclear State (John Calder, Publishers, Ltd., London, 1979), p. 155.

24. The Department of Energy's 'Working Document on Energy Policy', published in October 1977, reduced its projected energy demand for the United Kingdom made only 4 months earlier by 10 percent.

25. D.O.E., Energy Policy: A Consultative Document (HMSO, London, 1978), p. 55.

26. I.C. Bupp and R. Treitel, The Economics of Nuclear Power: De Omnibus Dubitandum (Harvard Business School Press, Cambridge, 1976), p. 82.

from alternative sources such as solar, geothermal, wind, wave, biomass, and fusion (discussed in a later sub-section of this chapter). All of these issues are of central importance in the attempt to properly evaluate the future role of nuclear power in the energy economy.

A key question in the nuclear power debate is whether enough uranium will be available to meet future nuclear power needs. The answer to this question is essential to enlightened decision-making regarding Plutonium recycle and the breeder reactor, since the urgency of the development of these technologies is premised on an anticipated shortage of world uranium supplies. Dr. S.E. Hunt, for example, has argued that a future expansion of non-breeder reactors, even with fuel recylce, on a global scale will 'exhaust the supplies of commercially viable uranium before adequate supplies of Plutonium have been built up to provide the cores for a significant fast breeder programme'.[27] In addition, Peter Chapman has estimated that such a non-breeder programme would exhaust the world supply of uranium by the year 2015.[28] Consistent with this projection, the United Kingdom's Department of Energy has forecast a critical supply of uranium reserves early in the twenty-first century unless fast breeder reactors are developed and put into operation as soon as possible. This is projected along with the assumption of a continuation of the uranium reprocessing currently carried out at Windscale. Related to this issue of limited uranium/

27. S.E. Hunt, 'Fuel Recycling', in J.S. Forrest, op.cit., p. 53.

28. Peter Chapman, Fuel's Paradise: Energy Options for Britain (Penguin Books, Harmondsworth, 1975), p. 143.

uranium reserves, is the potential problem of slowed uranium production after the more accessible ore has been exhausted.[29] These, and similar arguments put forward by 'hard path' advocates, generally assume a world wide uranium reserve of around 1.6 million tons, with roughly an additional 1.7 million tons anticipated to be discovered by the end of the century.[30]

Such estimates of uranium reserves have recently been criticised as being substantially in error on the low side. Critics, citing a lack of incentives for uranium exploration and reserve development, argue that the constraints on uranium supply are not physical but economical, and result from a conservative industry and a market that is anxious for protective long-term contracts. In 1974, Milton Searl argued that the geographic confinement of uranium exploration and the standard technique of shallow drilling (predominantly to 400 feet), have produced a distorted picture of uranium supplies. By extrapolating both depth and areal extent, he arrived at a much greater uranium potential - ranging from a low estimate of 7.7 million tons to a high of 29 million tons for the United States alone.[31] While not quite as optimistic as this, the mid-1976 estimates for worldwide uranium resources, published jointly by the Organization for Economic Cooperation and Development (OECD) and the International Atomic Energy/

29. L.G. Brookes, 'The plain man's case for Nuclear Energy', Atom, No. 234, April, 1976.

30. S.E. Hunt, International Journal of Environmental Studies, No. 8, 1976, p. 235.

31. See T.D. Mount and L.D. Chapman, Proceedings of the Workshop on Energy Demand, (IIASA, Luxembourg, Austria, 1976), p. 84.

Energy Agency (IAEA), did support an optimistic forecast for uranium reserves. Dividing uranium potential into two classes of 'reasonably assured' and 'estimated additional', the OECD/IAEA report listed a world reserve of 1.6 million tons of uranium up to a £7.50 cut off level per pound of ore, plus an additional 9 million tons up to a £15 cut off level. Estimated additional resources were given at 1.3 million tons up to the £7.50 level, and a projected 1.65 million tons of uranium ore up to the £15 cut off level. The results of this projection, a worldwide total of 5.5 million tons of uranium ore, seem to support the conclusion of the Nuclear Energy Policy Study Group of 1976: 'We see no reason why uranium resources could not be developed to supply fuel for light water reactors up to and beyond the end of the century, at costs that would not exceed by much the spot prices at which small quantities have been sold in 1976'.[32]

Consequently, an alternative conclusion to the urgent development of the breeder reactor and of the recycling of Plutonium is possible. This alternative does not foresee a pending uranium shortage, resulting from a continued expansion of the fission nuclear programme throughout the remainder of this century. Instead, a future of intensified exploration for uranium ore and a greater effort of exploiting known uranium resources is envisaged, to yield enough uranium ore for nuclear fuel to last another century or so.

In stark contrast to this is the projected future of natural oil and gas supplies. The general consensus among energy experts on this/

32. As quoted by M. Ross and R.H. Williams, Bulletin of Atomic Scientists, No. 32:9, November, 1976, p. 37.

this issue is that it is very unlikely that these two energy sources will be available in sufficient quantities to meet the future demands for energy. The only point of debate, in fact, appears to be the time scale of when these resources are anticipated to reach exhaustion. Even before the oil scare of the mid-1970s, due to the doubling and redoubling of oil prices by the OPEC nations, predictions of the disappearance of oil and gas reserves in as little as a couple of decades were being made. The 'Statistical Review of the World Oil Industry', for example, published figures in 1967 which indicated that oil resources would be available for only another 31.7 years.[33] Sir John Hill, the Chairman of the United Kingdom's Atomic Energy Authority, has subsequently interpreted this estimate in light of projected economic growth and growing demands for energy, and concludes, 'The situation is more serious than this because the shortage comes not when we have burnt the last drop of oil or the last puff of gas, but when production can no longer expand at the rate of increasing demand. This point of time is about 15 years away ...'[34] Following the quadrupling of oil prices by OPEC, this pessimism concerning rapidly diminishing oil supplies has become fashionable among the advocates of the 'hard path'. Others have countered this view by pointing to a long string of earlier predictions of oil and gas shortages, each of which has so far turned out to have been premature.

Nevertheless, whether the depletion of oil and gas reserves is pegged at fifteen or at fifty years, it appears to be clear to most/

33. As quoted by Hugh Montefiore, Can Man Survive? (Fontane Books, London, 1970), p. 25.

34. John Hill, 'The Energy Gap and the Fast Reactor', in J.S. Forrest, ed., op.cit., p. 15.

most energy forecasters that alternative sources of fuel must be developed. This is not to write off oil and gas. Indeed, these two fuels still furnish about seventy-five percent of the total primary energy in the industrial nations of the west. While that share is bound to decline, oil and gas will undoubtedly continue to be the largest source of energy throughout the remainder of the century. Yet, with an annual oil consumption among the non-communist nations of 17 billion barrels, the projected world oil reserve of 1,350 billion barrels begins to look quite limited. Gas depletion is equally inevitable. Thus, the important issue becomes how to reorient a dependence on oil and gas to alternative energy sources by the turn of the century.

Within this context, the prospective contribution of the coal industry to future energy needs appears to be very great. In terms of coal reserves alone, the United Kingdom's Department of Energy has reported that the present coal exploration programme in Britain is adding 500 million tons of coal to known reserves annually, which in 1978 was listed as 190 billion tons.[35] Assuming only known extraction methods, this computes to more than 300 years of coal supplies for the United Kingdom at the present rate of exploitation. International estimates of coal reserves range from ten to sixteen trillion tons, or approximately 600 to 1,200 years of supply at the present rate of total world energy use. Even the most pessimistic observers admit that coal will 'be with us for quite a time'.[36]

35. Department of Energy, Energy Policy: A Consultative Document (HMSO, London, 1978), p. 26.

36. Barbara Ward and Rene Dubos, Only One Earth (Penguin Books, Harmondsworth, 1972), p. 185.

While coal reserves are very large, extraction and use of coal in an environmentally acceptable way present many difficulties. Constraints such as the prohibition of strip mining, the rising restrictions on emissions of particulates and pollution from the oxides of Sulfur and Nitrogen, the environmental concerns involving Carbon Dioxide and its potential effect on climate, the levying of more strict controls on water usage in coal production, and increased public opposition to the siting of power plants have added to the uncertainty of the rapid expansion of the coal industry. In addition, recently imposed health and safety regulations in coal mining, plus the possibility of falling oil prices and the prospect of an increasing cost differential in favour of nuclear power, have acted to deter capital investment in the coal industry (the comparative economics of coal and nuclear power are discussed in the next section).

Encouraging prospects for the environmental acceptability of coal come primarily from the technology of Fluidized Bed Combustion (FBC). This technique mixes ground coal and limestone, or dolomite, with injected air which enables the coal to burn more efficiently while removing the sulfur at the same time.[37] If perfected, FBC will allow coal to economically replace oil in a wide range of industrial uses, including cogeneration (the production of electricity along with industrial heat or steam), and central station electric power. Other encouraging prospects for coal utilization are in the areas of synthetic oil and gas manufacturing. Without the advent of/

37. For a detailed description of this process see A.M. Squires, 'Applications of Fluidized Beds in Coal Technology' in J.P. Hartnett, ed., Alternative Energy Sources (Washington, D.C., Hemisphere Books, 1977).

of new technologies, however, these processes will remain considerably more expensive than natural oil and gas, and will primarily exist as future options.

In conclusion, it appears that coal reserves are more than adequate to become once again the primary source of energy in the industrialised countries for well into the future. Even assuming a rapid expansion of coal exploitation in response to higher oil prices, real coal costs would probably not have to rise significantly until after the turn of the century. In the words of the British Department of Energy, 'This is a classic situation justifying new investment'.[38] Even some 'hard path' advocates admit to the probability that cost increases due to higher mining safety standards, environmental controls, and the exploitation of more difficult coal deposits will be offset by technological improvements in mining and transportation. The prospects for coal should not be underestimated, then, since it presently stands as nuclear power's main competitor, and will, in all probability, become the material from which synthetic gas and oil will be manufactured.

Comparative Economics of Coal and Nuclear Power

While comparative cost estimates for the coal and nuclear energy alternatives are beset by many uncertainties, such as costs escalation and the unknown effects of future legislation, such an analysis is necessary, as the choice for the future generation of baseload power may well be between coal and nuclear power.

38. Department of Energy, Energy Policy: A Consultative Document (HMSO, London, 1978), p. 27.

The cost of electricity from nuclear plants stems primarily from the capital charges from the plant, and these charges have been dramatically escalating in the last ten years. In fact, the cost per kilowatt for plants which became operational in 1976 was double that for those which became operational in 1970. This escalation, which has been markedly higher than the rate of inflation, plus the historical trend of construction cost overrun, often by a factor of two or three times the original estimate, has recently cast doubt on the ability of the nuclear industry to predict or control costs for future plants. In the Bechtel Energy Supply Planning Model,[39] direct construction costs for a 1,100 MW light water reactor were equivalent to $418 per kilowatt in 1974. By the time indirect or owner's costs had been added to this, the total installed cost amounted to $585 per kilowatt.[40] By 1976 this figure had climbed to $688 per kilowatt.[41] Advocates of the 'hard path' energy strategy claim that this cost will tend to level off in time. Contending that more experience and design standardisation will bring construction costs under control, and that shortened regulatory processes will speed up construction times, they project escalating costs to gradually nose back down to meet the general rate of inflation. 'Soft path' advocates, on the other hand, foresee an opposite trend. Arguing that because the total energy required in building, operating, and decommissioning a nuclear power plant is not greatly less than the plant's lifetime generation of energy, they claim that as 'energy/

39. M. Carasso, et.al., The Energy Supply Planning Model (NTIS, Springfield, Virginia, August, 1975).

40. As computed in Amory Lovins, op.cit., p. 106.

41. Ibid., p. 108.

'energy accountability' becomes a more important factor, nuclear plant cost will become decidedly higher.[42]

Another major issue in the cost of nuclear generation of electricity is the 'capacity factor', which is the total amount of electricity actually produced by a unit in a year, divided by the amount of electricity the unit could produce while running at full capacity for the entire year. There appears to be some controversy about how to compute this factor, since nuclear reactor performance is affected by size, age, seasonal variations, environmental and safety features installed, and other more minor considerations. Additionally, there is a question of how to average the capacity factors for a number of nuclear plants. One method is to average all units equally regardless of size. This tends to raise the overall figure significantly since older and smaller units have better performance records than newer and larger ones. Another method is to weight each unit according to the energy it actually generates. This raises the average capacity figure to an even greater extent since those units not operating, i.e. with a zero capacity factor, simply drop out of the calculation. A third method is simply to weight each unit in proportion to its own design rating. This procedure appears to be the least dubious, and gives an average capacity factor for all nuclear units of 57 to 58.3 percent.[43] Nuclear power supporters claim that there will be improvements beyond this percentage as the nuclear industry matures. They also point to/

42. See Paul Sieghart, 'Nuclear Power: Setting the Scene', The Tablet, August 13, 1977, p. 764.

43. See Amory Lovins, op.cit., p. 110; or The Council on Economic Priorities, Power Plant Performance (CEP, New York, 1976), Table 10.4.

to refuelling designs recently developed by Westinghouse, which could reduce the time required for reactor refuelling from thirty days to one week, which would tend to slightly increase the capacity factor. Nuclear opponents dismiss this claim, contending that it is other required maintenance which necessitates the long shut-down during the refuelling period. Regardless of this issue, in 1976 the cost effect of a 57 percent capacity factor was between $1277 and $1404 per kilowatt produced.[44] This estimate was based on the Bechtel Energy Supply Model, and was consistent with the results obtained for the same year by the Electrical World-Brookhaven Model.[45]

Other, more insignificant factors which bear on the cost of electricity from nuclear plants are uranium costs and enrichment costs. While increases in the cost of uranium will obviously increase the cost of nuclear power, the net effect will probably be only a minor element in the total cost of nuclear power throughout the remainder of the century. For example, even if the cost of uranium were to escalate to £25 per pound, the cost effect per kilowatt produced would only be about 2.5 mills. The issue of enrichment costs is more uncertain. While it is probable that the cost of enrichment using gaseous diffusion or centrifuge will increase somewhat, as a factor of inflation and increased power costs, the net effect per kilowatt produced will probably be negligible. Enrichment using the still experimental laser isotope separation, on the other hand, could bring nuclear plant costs down, as this process extends uranium resources by/

44. Amory Lovins, pp. 109-110.

45. M. Beller, ed., Sourcebook for Energy Assessment (NTIS, Springfield, Virginia, 1975), p. 34.

by as much as 35 to 70 percent, and is a cheaper enrichment technique as well.

It is virtually unknown what the cost effect of spent fuel storage, transportation, and disposal will be on the future generation of nuclear energy. Without reprocessing or Plutonium recycle, these costs could be as low as 0.4 mills per kilowatt produced. Nuclear opponents, however, claim that the technology necessary for proper waste disposal will raise this cost dramatically.

Other unknowns that are simply omitted from nuclear cost computations, yet may be highly significant in the long term use and continued development of nuclear power, are: land cost, taxpaid regulation and security services, federal research and development, and decommissioning service. Nevertheless, a total cost of nuclear power, based on the Bechtel and Electrical World Brookhaven Models, amounted to between \$3150 and \$5000 per kilowatt delivered in 1976.[46]

The cost of coal-fired power has also risen significantly in the last few decades, reflecting more stringent safety, health, and environmental standards. Consequently, the cost of mining and transporting coal presently accounts for 30 to 60 percent of the total cost of the generated electricity. The base price of coal has also risen recently, as a result of OPEC's increase in the price of oil, and is now double the pre-embargo level of the early 1970s. As mentioned in the second section of this chapter, supporters of coal power claim that these cost increases will stabilise as technological improvements are developed in coal mining and transportation. This may be the reason why the Department of Energy has optimistically/

46. Amory Lovins, op.cit., pp. 111-112.

optimistically projected a total output of 135 million tons of coal by 1985, and of 170 million tons by 2000.[47]

Capacity factors for coal plants operating without sulfur removal techniques are generally estimated to be 67 percent, 5 to 10 percent higher than those for nuclear plants. If sulfur removal is utilized the figure becomes less certain, as there is little experience with this technology in large plants. For example, it is unknown what effect desulfurization failure would have on the operation of a plant. Coal power advocates claim that the effect of such failure would be negligible, since either a temporary variance would be granted, or the plant would switch to a reserve of low-sulfur coal until the failure were overcome. Coal opponents argue that such a failure would force the plant to shut down operations, therefore lowering the capacity factor to a level of 60 percent or so. The Bechtel Model compromises toward the lower figure with a capacity factor estimate of 62 percent, which computed to about $120 per kilowatt in 1976.[48]

One factor which causes a great deal of variation in the base price of coal is the method of production. Because underground mining, an environmentally acceptable method, is labour-intensive, with wage increases generally in excess of the rate of inflation, it is a considerably more expensive way of producing coal than strip mining. Other variables in the cost of coal include land lease opportunities, Government policies regarding the expansion of the industry and industrial taxation, and transportation expenses. Taken together/

47. Department of Energy, Energy Policy: A Consultative Document (HMSO, London, 1978), p. 31.

48. Amory Lovins, op.cit., p. 113.

together, these factors computed to a total fuel cycle cost of about $106 per kilowatt in 1976.[49]

The final major cost in the generation of coal power is the capital charge for the plant. Cost estimates for plants designed to burn low-sulfur coal without gas desulfurization ranged from $345 to $680 per kilowatt in 1976. Plants designed to burn high-sulfur coal with flue scrubbers ranged from $465 to $743 per kilowatt in the same year.[50] Opponents to coal power maintain that the costs for coal plants are sure to escalate dramatically in the future, as limits will undoubtedly be set on the emission of nitric oxides, heavy trace elements, and toxic and carcinogenic organic compounds. Coal supporters argue that advanced technologies, for example, fluidized beds, will be effective in offsetting such restrictions. Nevertheless, the total cost of coal power, computed by Amory Lovins for 1976, amounted to $2476 per kilowatt delivered.[51]

In conclusion, it appears that coal generated power was, on the average, somewhat less costly than nuclear power in 1976. Given future uncertainties and the number of variables which will effect future costs, the certainty with which this trend can be extrapolated into the future is a matter of dispute.

Alternative Sources/

49. Ibid.

50. M. Beller, ed., op.cit., p. 41.

51. Amory Lovins, op.cit., p. 114.

Alternative Sources

Three serious alternative energy sources to the nuclear and coal options are solar energy, geothermal energy, and fusion. A fourth highly potential source of energy is more efficient use of existing sources through conservation, cogeneration (the combined production of electric power and process heat), and improved distribution. Alternative sources of energy with somewhat less potential are wind, wave, and biomass. 'Soft path' advocates claim that all of these sources of energy can be successfully exploited in the relatively near future. Supporters of the 'hard-soft path' argue that whether or not these sources can, in fact, contribute in the short term, they should be rapidly developed as they will definitely be needed in the intermediate to long term, or after the turn of the century.

Of these alternatives, solar energy appears to be the most promising, since it is essentially unlimited. It has been estimated that the amount of solar energy falling on the United States alone is around 44,000 quads[52] per year. If used at only 10 percent efficiency, this amount of energy would be able to supply the present annual consumption of electricity in the United States 650 times over. While there is no doubt that solar energy can be used to generate heat and electricity, it is not so certain how much it could cost to collect and use it for these purposes. The energy intensity of sunlight is much lower than that of the heat-generation portion of a nuclear or fossil fuel plant. The problem is finding a way of utilizing this low-density energy of sunlight at a low capital cost. Further complications/

52. A quad of power is defined as a measure of energy equal to 10^{15} British Thermal Units (BTU).

complications to the solar energy issue are the problems associated with the variability with which sunlight arrives at the Earth's surface, and the mismatch between time of production and time of use. The solution to these problems seems to lie in the need for large-scale storage of solar energy. Several techniques for energy storage currently being developed are thermal storage in hot oil or hot rocks, electrical storage in batteries, and mechanical storage using pumped water or compressed air. Advocates of the 'soft path' claim that once these storage techniques have been developed, solar energy will be cost competitive with nuclear and coal-fired power. 'Hard path' supporters contend that this will never be the case since, as they claim, up to one-third of solar energy collected is lost in the transfer to and from storage. They also point to the major problem of efficiency loss during long transmissions of solar energy. Solar energy advocates argue that these issues will be solved with technological improvements and with solar energy maturity. They also point to the present advantages of utilizing small-scale solar power, such as space heating and cooling, simply because there is no energy transportation or transmission required.

Presently, there are three possible ways of using the Sun's energy.[53] The most widely known of these is photothermal conversion. This technique involves converting solar light to heat, and then utilizing the heat for heating water and buildings, driving engines/

53. For an extensive discussion of the uses of solar power see: Ford Foundation Energy Project, A Time to Choose: America's Energy Future (Ballinger, Cambridge, Mass., 1974); or G. Eppen, Energy: The Policy Issues (Chicago University Press, Chicago, 1975).

engines, and doing other forms of work. Already this form of energy is proving to be relatively inexpensive, particularly as a substitute for direct electrical heat in residential use. In fact, it is now quite feasible for houses built in sunshine belts to get all their energy from solar collectors at a cheaper price than either oil, gas, coal, or nuclear power.[54] A second, more complicated method of using solar energy is to convert large amounts of sunlight to high-temperature heat. This heat would then be applied to the operation of heavy industrial processes. This technique is still in the early developmental stage, and is much more hypothetical than solar space heating. Present estimates of capital costs for kilowatt of power produced for proto-type plants using this technique appear to be about \$2,000, or two to three times the capital costs for nuclear plants, and three to four times that for coal plants. The final method of using solar energy is the process of photovoltaics. This is a way of converting the light from the Sun directly into electricity. Already efficiencies of about 10 percent have been achieved by solar cells, which are commonly used to power satellites and remote communications stations. The major problem with this technology is that current collector costs are about \$200,000 per kilowatt produced, which is several hundred to one thousand times what is required to make photovoltaics cost competitive with nuclear or fossil plants.

Advantages that solar energy has over the 'hard path' technologies include minimal risks to the environment, techniques which are relatively simple, and its availability all over the planet. Solar/

54. T.M. Thomas, World Energy Sources: Survey and Review (Random House, New York, 1976), p. 84.

Solar energy is inherently less damaging to the environment because its generation does not disrupt the ecosphere with radioactive materials, waste heat, or other pollutants. The relatively simple photothermal techniques[55] are advantageous because they tend to be labour-intensive and can be produced from the raw materials available to even the poorest countries. Solar power advocates claim that for this reason alone, the use of solar energy by the developing nations of the world would go a long way toward solving their formidable problems of high unemployment among the unskilled, balance of payments deficits, and dependence on developed countries. Advocates of the 'soft path' argue that nuclear power stations would tend to have the opposite effect in these countries. They claim that nuclear reactors would increase the technological dependence of the Third World on the developed world, and that nuclear power would reinforce social inequalities, since it would be largely the urban rich who would be able to profit from this costly form of electricity.[56] Nuclear power supporters dismiss these arguments by claiming that in denying developing nations the option of nuclear energy, the developed countries would be denying them the opportunities to enjoy economic and material advancement.[57] Solar power advocates counter-charge with the fact that as solar energy is available all over the plant, it lends itself to national and local autonomy and self-sufficiency. They claim that this is impossible/

55. For an example of simple, do-it-yourself solar heating unit see the account given of the Iona Solar Project available through the Science, Religion, and Technology Office, 121 George Street, Edinburgh.

56. Bill Shore, 'Nuclear Power: The Alternatives', The Tablet, August 27, 1977.

57. Phillip Searby, 'Nuclear Power: The Moral Question', Atom, May 1978, No. 259, p. 137.

impossible with nuclear power stations, as these must be very large and centralised, and tend to focus political and economic power on the dominant interests of the status quo.

While solar energy currently represents only a small fraction of generated world electricity, it seems realistic to project an increasing importance of this form of power over the next two decades. 'Hard-soft path' supporters stress the availability of solar energy for the long run. They claim that while solar power will probably not be an economic alternative to either coal or nuclear power in the next two to three decades, it is a definite alternative to the development of breeder reactors, fusion, or coal power in the twenty-first century. British Energy Policy has recently acknowledged this possibility, and is now accelerating the development of cost-effective solar space and water heating systems for immediate local application.[58]

Geothermal energy is the natural heat contained in the Earth's crust. It has been estimated that the Geothermal heat in the outer ten kilometers of the Earth's curst under the United States alone is equivalent to about 1,000 times the heat contained in the total U.S. coal reserves.[59] While most of this vast store of energy is too diffuse to be economically useful, a fraction of it is concentrated and appears to be recoverable. At present, there are five types of geothermal energy resources generally recognised.[60] These five are/

58. Department of Energy, Energy Policy: A Consultative Document (HMSO, London, 1978), p. 60.

59. From the First Annual Report of the Geothermal Research and Development Programme, January, 1977, as quoted by C.B. Reed, Fuels, Minerals, and Human Survival (Ann Arbor Scientific Publications, Inc., Ann Arbor, 1975), p. 28.

60. For a comprehensive study of geothermal energy resources see: R.S. Livingston and B. McNeill (eds.), Beyond Petroleum, (Stanford University Institute for Energy Studies, Palo Alto, 1975).

are: hydrothermal convective, or regions containing high temperature water at shallow depths; hot dry rocks; geopressured resources, or pressurised water reservoirs in sedimentary basins; normal gradients, or conduction-dominated areas produced by heat flows; and magma, or molten rocks.

The vast potential for each of these energy sources has, at least so far, been offset by the complex problems inherent in their exploitation. For example, hydrothermal convective systems, which are cost competitive with fossil fuel and nuclear power for low-quality heat, is generally limited to populations living within a few kilometers of the resource. The utilization of the other types of geothermal energy appears to be frustrated by such technical obstacles as deep drilling, difficulty in handling corrosive water, highly mineralised waste water and steam, air pollution from dissolved hydrogen sulfide as the hot water flashes into steam, high thermal release to the environment, the hostility of the geothermal environment, and land subsidence. While none of these technical obstacles are regarded as being insurmountable, the economic costs of overcoming them appear to be appreciable. Consequently, most energy experts tend to agree that the wide-scale exploitation of geothermal energy should be delayed until either other sources of energy become very expensive, or less costly ideas for geothermal exploitation are presented.

Fusion, like solar energy, offers the promise of practically unlimited energy. In the fusion process, light atoms react to produce a heavier element with the net release of energy. The Sun, which is a giant fusion reactor, is often used to demonstrate the potential of this process. While there is little doubt that such a reaction is/

is possible to create,[61] there is some dispute as to its feasibility as a practical energy source. The basic problem seems to be the inability to construct a reactor that is capable of producing a net energy gain. In all of the experimental reactors designed so far, the auxillary devices that are required to support the very complex fusion reaction use more energy than is produced by the reaction.

Other major obstacles to the development of fusion reactors are near prohibitive costs, and environmental and safety problems. The incredible costs required for research and development of fusion power, estimated to be in the 20 billion range,[62] are largely a function of capital costs. Unless more simplistic designs for fusion reactors become feasible, the basic technology of the fusion process will prohibit its ever being cost competitive with even the breeder process. While fusion power has the promise of avoiding some of the social costs of coal and nuclear power, it would not be problem-free. Indeed, more radioactive neutrons are produced per kilowatt in a fusion reactor than in a fission reactor, and these neutrons are of higher energy and are, therefore, more difficult to shield, However, as there are no fission by-products created in a fusion reaction, the problem of long-term radiation would be about one hundred times smaller than for a fission reactor of comparable power. A minor problem to the development of fusion power could be resource constraints of the special fuel materials required, such as Lithium and Beryllium. The basic fuel, Deuterium, is, however, virtually inexhaustible.

61. In fact, the fusion process is the working principle of the Hydrogen Bomb.

62. W.C. Patterson, Nuclear Power (Pelican, Harmondsworth, 1976), p. 87.

The fourth and final highly potential source of energy appears to be in the area of conservation. This not only includes the more efficient utilization of present energy sources, but also the development of more economical techniques, such as the cogeneration of electricity and steam for commercial use. Obviously, the present realities of decreasing amounts of some fossil fuels, escalating energy costs, and two-thirds loss of energy potential during the conversion of nuclear and fossil fuels to electrical energy, justify conservation investments today. It has been estimated that in 1975, a full 31.2 percent of all of the energy delivered to energy consumers in the United States was either wasted or thrown away.[63] Undoubtedly, as higher energy costs become an accepted fact of life, energy consumers will begin to replace inefficient equipment, add insulation, buy diesel rather than spark-ignited machines, and adopt other conservation measures to the extent that they appear economically desirable. Similarly, energy producers will probably use such techniques as combined-cycle electrical generation (a gas turbine followed by a steam turbine), and industries will make more effective use of the 'waste' heat currently produced in the generation of electricity through the process of cogeneration. The role of the Government in encouraging these kinds of conservation measures is critical. Certainly, Government grants and incentives for conservation use, support of research and development in conservation, and promulgations of energy performance standards, would help stimulate this public to realise conservation's vast potential.

63. K.W. Ford (ed.), The Efficient Use of Energy (American Institute of Physics, New York, 1975), p. 59.

Improved technology in energy transmission could also play an important role in the utilization of present and future energy sources. If it were possible to transmit electricity more economically over long distances, coal and nuclear plants could be sited more flexibly, reducing capital and associated social costs. In the case of nuclear plants, remote siting would be particularly significant since it would greatly reduce the consequences of a serious accident. Unfortunately, long-distance transmission of electricity is extremely expensive today, and does not appear to be economically feasible for the near future.

Alternative energy sources with rather limited potential for widespread use are wind, wave, and biomass. While wind power is currently being investigated for applications other than the generation of electricity - such as for pumping heat and water or for compressing air - present costs for the traditional uses of roto-style windmills are substantially higher than for fossil or nuclear plants. The limited lifetime of windmill blades and rotors is the major source of these high costs. Also, the problems associated with energy storage and back-up supply systems help to push wind power above the cost competitiveness of nuclear and fossil fuels. Nevertheless, wind power does have the potential of meeting at least some of the electrical energy requirements in certain areas. For example, the concept of using windmills in the one to four megawatt output range in coastal shallows is currently being seriously evaluated in the United Kingdom.[64] The various tidal wave, and other oceanic schemes appear even much further off in economic feasibility than wind power.

64. Department of Energy, Energy Policy: A Consultative Document (HMSO, London, 1978), p. 61.

Obstacles to the development of oceanic power include working with resources of extremely limited efficiency and pressure differences,[65] developing equipment capable of surviving the severe environment, and transporting the produced energy from the sea to the land. Proponents of oceanic power claim that the extrapolation of existing wave and tidal power technologies to much larger units would be accompanied by a proportionate reduction in cost per kilowatt produced. Sceptics contend that not only is such an assumption highly questionable, but that the current estimate of $2000 per kilowatt of produced oceanic power is not even near to being cost competitive with nuclear and fossil fuel power, once low load-factors and transmission needs are accounted for. Biomass, or the use of vegetable matter for fuel, is the final alternative source of energy. Currently, one pound of dry plant matter yields about 7,500 BTUs. Thus, it would take approximately 100 million acres to provide biomass-generated energy for the present level of electrical consumption in the United States alone. Such wide-scale applications of biomass would obviously pose serious problems of adequate land availability and fertiliser requirements. Use of biomass on a large scale would also have to deal with the question of using well-watered soil that is nutrient rich for fuel rather than for the production of cash crops. Also, the environmental impacts would not be small. Opponents of this form of energy use the analogy of a logged forest and pulp mill for each 1,000 megawatt biomass installation. Proponents, on the other hand, estimate that a 1,000 megawatt plant could operate from the output/

65. For example, the maximum efficiency for operating a heat engine on the 20°C ocean thermal-gradients is probably only 2 percent.

output of biomass raised by intensive cultivation within a radius of twenty to thirty miles from the plant.[66] This, they claim, would tend to reduce transportation costs, and would allow the recovery of important trace elements by plowing the ash back into the soil. Biomass advocates also contend that burning plant matter rather than fossil matter would avoid the serious consequences of the greenhouse effect,[67] since the carbon dioxide put into the air by burning biomass would be offset by the removal of carbon dioxide in the photosynthesis that creates it. While biomass may be economical on a limited scale as a by-product of agriculture or wood-product operations, it is unlikely that it will be cost competitive with nuclear and fossil fuels on a large scale in the foreseeable future.

66. R.S. Livingston and B. McNeill (eds.), op.cit., p. 137.

67. The greenhouse effect is produced by the re-radiation of low temperature infrared radiation back to the earth by carbon dioxide and water vapour in the atmosphere.

HEALTH AND ENVIRONMENTAL ISSUES OF NUCLEAR POWER

Nuclear power has been widely attacked as a threat to human health. Critics are primarily concerned with the possibility of catastrophic reactor accidents, and the health and environmental problems associated with nuclear wastes and plutonium. These risks are indeed real, and must be acknowledged in any assessment of nuclear energy.

Health Effects

The use of nuclear power to generate electricity inevitably results in risk to human health. Radioactivity is encountered at virtually all stages of the nuclear fuel cycle - in mining and milling, in fuel fabrication and transport, in reactor operation, and in waste management and disposal operations. Small quantities of radioactivity are normally released at each stage, affecting workers or spreading beyond the nuclear facilities to the local environment. Proponents of nuclear power are usually quick to point out that any such radioactive materials released are an extremely small fraction of normal background radiation. Critics argue that regardless of potency, radioactive particles trapped in body tissues or left in the environment will remain continuing sources of radiation for centuries. Thus, while the rates of exposure may be small, the cumulative effects will be great. Paul Sieghart, the Vice-Chairman of the Council for Science and Society, underscored this point when he stated, "Every increase in the average dose of radioactivity to which a population is subjected will produce some increase in environmental cancers, leukaemia, and genetic illness in future generations; there is no 'threshold' below which/

which radioactivity has no effect."[1] Nuclear power advocates usually counter this with the claim that not only do statistics verify that working in atomic plants is safer than in any other energy industry, but that any minimal risk entailed in nuclear power generation is more than compensated for by its benefits. D.W. Clelland, Manager of the Research and Development Programme at British Nuclear Fuels, Ltd., has tried to put the hazards of nuclear power into the following perspective: 'The risk of the nuclear industry and its waste disposal component is less to the individual than many other activities such as, smoking $1\frac{1}{2}$ cigarettes, driving 50 miles by car, or being struck by lightning.'[2] In arriving at a similar conclusion regarding the relative safety of the nuclear industry, Sir John Hill, the Chairman of the United Kingdom Atomic Energy Agency, has argued that since 'Skilled industries have a better life expectancy and lower death rate than the unskilled industries', and since atomic energy is a skilled industry of 'the highest quality', then 'atomic energy is one of the best industries to work in'.[3]

Assessments of health effects from nuclear power are complicated by the uncertainties about the effects of radiation upon man, and by the fact that there has been relatively little operational experience with nuclear reactors. The biological damage caused by radiation/

1. Paul Sieghart, 'Technology and People', The Tablet, 20 August 1977, p. 791.

2. D.W. Clelland, 'The Management of Radioactive Wastes from Reprocessing Operations', in J.S. Forrest (ed.), The Breeder Reactor (Scottish Academic Press, Edinburgh, 1977), p. 72.

3. Sir John Hill, 'The Abuse of Nuclear Power', Atom, No. 239, September 1976, pp. 6-8.

radiation varies according to the particular exposure to the particular radioactive material. The total dose is measured in rems,[4] and the dose rate is expressed in rems per unit of time. For example, radiological protection standards often list permissible dose limits in terms of the number of rems per year which may be received. The average whole body dose rates from natural and man-made radiation, in the United States, is approximately 210 millirems (mrem) per year. Of this, 80 mrem is attributed to man-made radiation, with nuclear power accounting for only 0.23 mrem.[5] While small, it must be born in mind that releases of radioactive materials may continue for years after power generation occurs, and may gradually build up in the environment or in human tissue. For example, the tailings from uranium mining and milling activities will continue to emit radioactive materials for many thousands of years at a nearly constant rate.

While the effects of very high doses of radiation have been well documented, the effects of low doses at low dose rates are virtually unknown. The principal non-hereditary delayed effect of radiation is cancer. There is usually a delay of years or even decades between irradiation and the appearance of cancer. This long latency period usually makes it impossible to identify a particular cancer as due to/

4. A rem is defined as a dose of rads (one rad is the equivalent of an absorption of 100 ergs of energy per gram of matter) multiplied by a biological effect factor.

5. For a thorough examination of radiation exposures from nuclear power generation see: Hugh Montefiore and David Gosling (eds.), Nuclear Crisis (Prism Press, Dorchester, 1977), pp. 37-61; Karl Morgan 'Should radiation exposure from the operation of nuclear power plants be reduced?', Anticipation, June 1979; and Bryan Wynne, 'The Politics of Nuclear Safety', New Scientist, 26 January, 1978.

to radiation. However, data collected on Japanese atomic bomb survivers, patients treated with maximum doses of X-radiation, Marshal Islanders who were subjected to atomic bomb fallout in 1954, uranium miners, pioneer radiation workers, various groups of radiotherapy patients, and radiation tests carried out on non-human species, do establish a statistical relation between radiation and the development of cancer. Estimates given by two separate study groups in 1972, on the correlation between low level radiation and cancer, appear to be in basic agreement that an additional 1 rem exposure per million of individuals would result in approximately 180 excess cancer deaths.[6] In addition to this, most studies agree that such an exposure would also increase the genetic defects in the population by a factor of five.

In assessing the health risks of the current nuclear fuel cycle, the estimate of 1 rem exposure per 2,000 to 2,500 individuals per reactor year, as the emitted radioactive does, seems to be generally accepted.[7] One-fifth of this total is calculated to come from mining and milling uranium, two-fifths from reactor operations and repair, and an additional two-fifths from radon emissions in mill tailings piles. If 180 latent fatalities per rem exposure per million people is assumed (see above), then the total health risks due to radiation exposure from nuclear power generation calculates to be/

6. Karl Morgan, op.cit., p. 62.

7. 0.23 mrem per person per year x capacity factor of 58 percent per year = 0.5 mrem per person per reactor year, or 1 rem per 2,000 individuals.

be 0.4 expected deaths per reactor year,[8] or an annual total of six nuclear radiation deaths in Britain alone. The attitude of the nuclear power industry to this hazard was summed up by L.G. Brookes as 'A risk that we regard as too low to bother with in the first place'.[9] Critics have attacked this kind of attitude as 'irresponsible', and argue, as Dr. Brian Wayne did in the New Scientist, that 'Apart from the vexed intellectual and moral problems involved in putting a cash value on human life, there is the further point that the "cost" of an increased discharge should really be the price that society is willing to pay to avoid it'.[10] Critics are also quick to point out that this figure does not include the hazards of plutonium recycle, reactor decommissioning, and uranium reprocessing, which are said to push up the expected death rate due to radiation by 60-75 percent.[11] They also argue that these calculations are open to question, as the basis of the equation is the operational performance of a new reactor. They suggest that exposures might go up with plant age, as a factor of equipment wear and accumulated contamination.

The likelihood and possible health effects of a major nuclear accident at an atomic power plant are also disputed concerns. Once again, the nuclear industry maintains that the risk of a major accident/

8. 1 rem per 2,000 to 2,500 individuals means that 1 million people are presently exposed to 1/400 to 1/500 of a rem, which equates to 0.36-0.45 deaths per reactor year.

9. L.G. Brookes, 'The Plain Man's Case for Nuclear Energy', Atom, No. 234, April 1976, p. 11.

10. Bryan Wynne, op.cit., p. 208.

11 L.A. Sagan, 'Human costs of Nuclear Power', Science, No. 177 (1972), p. 487.

accident is negligible. For example, L.G. Brookes argues that 'For a significant release of radioactivity a number of very unlikely events must occur simultaneously and the chances of this happening can be shown to be very low indeed'.[12] He also makes the claim that 'Even if a man lived next door to a nuclear power station he was 2,000 times more likely to be struck by lightning than harmed by a nuclear accident'.[13] Yet, major reactor accidents have occurred - Chalk River, Windscale, Lausanne, Brown's Ferry, and, of course, Three Mile Island. The mathematical process used to calculate the probability of a reactor accident has recently been criticised as being 'misleading'. Even the logic behing such a calculation is currently under attack. Dr. A.J. Coleman, the Head of the Mathematics Department at Queen's University, for example, has raised the point that 'The application of theoretical probabilistic calculations to real-life accident situations and pretending that such and such a probability of an accident is a scientific certainty',[14] is ethically questionable. 'One does not', he writes,

> 'compute the probability of death by automobile by studying the mechanisms of an automobile such as how the clutch works, how the brakes work, and how frequently these things fail. No doubt these have a part to play in automobile accidents, but I don't think this approach would ever enable you to come up with a reliable figure as to how many deaths you're going to have on the highway per year.' 15

12. L.G. Brookes, op.cit., p. 12.

13. Ibid.

14. A.J. Coleman ~~as quoted in~~ R.W. Jackson and J.D. Potworowski (eds.), A Nuclear Dialogue (Science Council of Canada, Toronto, 1976), p. 25.

15. Ibid.

Nevertheless, studies on the likelihood of a major reactor accident have been made and are often quoted by supporters and critics alike. The most comprehensive study to date appears to have been the United States Nuclear Regulatory Commission's 'Wash - 1400' completed in 1975. This study predicted that a major release of radioactivity by a reactor in a relatively dense population setting, with a relatively ineffective evacuation plan in operation, would kill at least 3,300 individuals immediately, and would give another 45,000 people intense radiation sickness that would probably result in death as well. In addition, the study estimated that the radioactivity would also directly cause 45,000 cases of fatal cancer, and 30,000 cases of severe genetic disorders as long-term consequences.[16] The probability of such a serious accident has been estimated to be about one in 200 million reactor years of operation.[17] Even if such odds happen to be correct, Paul Sieghart has pointed out that 'the accident could still happen tomorrow',[18] with another one happening the day after.

The health risks of plutonium are even more intensely debated. The greatest hazard appears to be the inhalation of small dust particles/

16. A more pessimistic estimate was given by the 'Sixth Report of the Royal Commission on Environmental Pollution', Nuclear Power and the Environment, September 1976; when it was predicted that a 10% release of radioactivity from a Fast Breeder Reactor would cause one million casualties.

17. World Council of Churches, 'A Report to the Churches', Sigtuna, Sweden - June 24-29, 1975, as presented by John Francis and Paul Abrecht (eds.), Facing Up to Nuclear Power (St. Andrew Press, Edinburgh, 1979), p. 186; and U.S. Regulatory Commission, Reactor Safety Study (Wash - 1400, 1975).

18. Paul Sieghart, op.cit., p. 792.

particles of plutonium, which would produce cancer. Plutonium can also translocate to other parts of the body, and tends to collect in the liver, bone, and gonads. It is also believed that this translocation is speeded up when a mixture of plutonium isotopes, such as that created by commercial reprocessing and recycle, is either inhaled or ingested. Certainly, plutonium-239's intense radioactivity and its half-life of 24,000 years make it one of the most hazardous substances known to man. Even Sir Richard Doll, Regius Professor of Medicine at the University of Oxford, has agreed that plutonium adds a dimension of responsibility to nuclear technology which does not exist with other technological projects.[19]

Environmental Effects

In addition to the direct effects on human health, the generation of nuclear power has environmental effects as well. The most serious potential problem appears to be changes in global climate, due to the heating of the atmosphere by nuclear plants. It has been estimated that if 'hard path' technology is used to meet a projected annual energy production rate of 4.5 percent, then in fifty years the average global artificial heat input would be about 0.2 percent of the Earth's radiation balance, which could cause melting of polar sea ice.[20] While thermal pollution is also a potential problem with coal plants, it appears to be a major one with nuclear plants as they are less efficient in converting heat, and lose 20-30 percent more heat to the environment.

19. Montefiore and Gosling (eds.), op.cit., p. 41.

20. Barbara Ward and Rene Dubos, Only One Earth (Penguin, Harmondsworth, 1972), p. 268.

Nuclear plants could also contribute to future climatic changes by the release of radioactive particles to the atmosphere. These particles affect atmospheric ionization, or the electrical properties of the atmosphere, and could alter cloud formation and precipitation. Of the particles released through the generation of fission power, krypton-85 appears to have greatest effect on atmospheric ionization. Present reactors release approximately 500,00 curies of krypton-85 per 1,000 MW of generated electricity. If, in the next thirty years, world-wide nuclear power generation increases to 1,000 GW, and the krypton-85 particles are released as they are now, the present atmospheric ionization level is predicted to increase by approximately ten percent.[21] Nuclear power advocates claim that it is now technologically feasible to remove most of the krypton-85 from the gaseous wastes. Critics claim that any method of removal would significantly add to the capital costs of nuclear plants.

In order to reduce some of the social hazards and problems associated with dispersed nuclear sites, the construction of huge nuclear parks, containing ten to forty 1,000 MW reactors, has been proposed.[22] Citing the major problems of atmospheric alterations, and the requirement of a substantial river flow capacity for reactor cooling, critics contend that such a concentration of nuclear plants would be untenable - particularly on the local or regional basis.

The principal hazard to land usage by the nuclear fuel cycle is in the mining and milling of uranium ore. At the present ore/

21. Sagan, op.cit., p. 502.

22. See Alvin Weinberg, 'Nuclear Energy at the Turning Point', Anticipation, November, 1977, No. 24, p. 25.

ore concentration of about 0.2 percent, twenty to fifty acres of land must be mined annually to produce enough uranium to support a 1,000 MW nuclear power plant. In addition, the amount of land required for milling operations and for the storage of tailings, is around thirty to seventy acres per 1,000 MW plant per year. The land used for tailings storage is of limited future use because of radiation hazards. As the richer and shallower uranium ores become depleted, greater quantities of earth will have to be removed to secure the same amount of uranium. Critics claim that within the next decade, the land requirements for the nuclear fuel cycle, without taking into account what will be needed for long-term spent fuel disposal, will surpass that which is presently required by the coal cycle. Supporters of nuclear power dismiss this point with the counter-argument that the great bulk of uranium mining occurs in arid or semi-arid regions with little economic value.

Radioactive Waste

While Radioactivity is present at most stages of the nuclear fuel cycle, the largest, most hazardous quantities are found in the spent fuels of nuclear reactors. Although the intense radioactivity of the material in the spent fuel decreases rapidly at first, being reduced by a factor of 1,000 during the first ten years, it is subsequently reduced much more slowly, by a further factor of 1,000 only after the next 100,000 years. The initial high radioactivity of the waste necessitates very careful handling and storage at the outset. The long term nature of the waste hazard necessitates fool proof measures protecting many future generations.

A light water reactor discharges about thirty metric tons of spent fuel per year. Each ton contains nearly thirty kilograms of fission products (the radioactive remains of fissioned atoms) and about ten kilograms of transuranic elements. Immediately at reactor shutdown, a ton of spent fuel contains about 300 million curies of radioactivity. After about ten years, this level has decayed to about 300 thousand curies.[23] Spent fuel also produces a great deal of heat: one day after reactor shutdown, thirty tons of spent fuel have a heat output of about 10,000 kilowatts; after ten years, this is reduced to about one kilowatt per ton.

It appears that the nuclear industry has long assumed that spent fuel would eventually be reprocessed. Consequently, nuclear waste has been allowed to accumulate at reactor sites, with no long-term waste disposal programme yet designed. Reprocessing, however, is now presented by some as more a complication than a solution to waste management, as it ultimately broadens the spectrum and potential difficulty of waste problems. The results of reprocessing are: a highly radioactive liquid waste 'stream', which has thus far proven to be unmanageable; the liberation of radioactive gases and volatile radionuclides from the original waste material; the creation of new, more unstable categories of waste isotopes; and a large volume of liquid waste containing small concentrations of radioactivity.
The recycling of plutonium in reactors adds further complications to the reprocessing system, as recycle results in higher concentrations of/

23. A curie is defined as the rate of decay of one gram of radium, or 37 billion radioactive disintegrations per second.

of americium and curium in spent recycle fuel than in ordinary spent uranium fuel. These elements present risks similar to those of plutonium. Additionally, not only does spent recycle fuel have higher plutonium concentrations than spent uranium fuel after reprocessing, but waste from multiple recycled fuel has higher concentrations of other long-lived transuranic elements than does spent uranium fuel. The net reduction in the transuranic content of waste is less than a factor of 10 rather than the factor of 200 which is generally projected from the 99.5 percent recovery rate in reprocessing.[24] Nuclear power critics tend to add to this list of reprocessing complications, the added risks of using plutonium in an active fuel cycle, and of reprocessing large quantities of radioactive materials. While nuclear proponents generally recognise that all these issues are complex problems, the nuclear industry appears to have adopted a somewhat casual attitude about their eventual solution. For example, in its submission to the British Council of Churches' public hearings on CFR-1, British Nuclear Fuels, Ltd., claimed that 'Present methods of storing (reprocessed) waste have proved to be an entirely satisfactory and safe way of isolating it from the environment for many tens of years ... a major international effort is nevertheless being devoted to methods of ultimate disposal, which will provide permanent safe isolation. There is no reason to doubt that an acceptable solution will be found.'[25] Nuclear power critics contend/

24. Quantities in this section are based on 'The Final Generic Environmental statement on the use of Recycle Plutonium in Mixed Oxide Fuel in light water cooled reactors', as quoted by Jackson and Potworowski (eds.), op.cit., p. 14.

25. Montefiore and Gosling (eds.), op.cit., p. 56.

contend that this is an irresponsible attitude, as well as being grossly unfounded. They argue that experiences such as the 115,000 gallon leak of high-level radioactive liquid waste at Richland, Washington, U.S.A., in 1973 - which went forty-eight days before being noticed, and nearly succeeded in reaching the water table of the Columbia River - are the forerunners of catastrophe. Critics also point to the fact that waste leakage is not uncommon. Richland, Washington, alone experienced eighteen major leaks, totalling 4929,400 gallons of high-level radioactive waste, from 1958-to 1974. Moreover, approximately 31 million gallons of radioactive waste were intentionally dumped at Richland in the late 1950s, and, until the early 1970s, liquid wastes from the plutonium finishing plant at Richland were released directly into the soil.[26]

The alternatives to early reprocessing are either spent fuel storage, until it is evident if the plutonium contained in it will be needed for breeder reactors, or permanent disposal of the spent fuel. Unfortunately, since reprocessing has been generally assumed to be the next step in the nuclear fuel cycle, it appears that very little technical consideration has been given to either alternative. While some spent fuels have apparently been kept in aqueous environments for as much as ten years without appreciable degradation, a necessary and generally recognised further stpe is to provide facilities for these fuels which offer protective barriers against accidents and sabotage. Current suggestions for such long-term storage of spent/

26. The figures for waste leakage at Richland have been supplied by Mr. Ronald Prosser, Manager of Special Projects Division, Hanford Operations, Rockwell International Co., Richland, Washington.

spent fuels include retrievable storage in geological or in oceanic repositories. Nuclear advocates propose that this could be accomplished in such a way as to constitute permanent disposal should the plutonium component not be needed. Critics point to the ever-present risk, inherent in any storage scheme, that radiotoxic waste might some day find its way into the human environment. They question the right of contemporary society to create such a relatively eternal hazard for the future of civilization.

As far as permanent disposal of waste is concerned, there appear to be four major methods that are currently being studied. These methods are ocean and sea bed disposal, disposal in geological formations on land, ice sheet disposal, and extraterrestrial disposal. Present research seems to indicate the feasibility of vitrifying the waste into glass blocks prior to permanent disposal. Mr. Michael Heseltine, the United Kingdom's Secretary of State for the Environment, has stated that a plant to manufacture such glass blocks will be operational in Britain by about 1990.[27] Apparently, these blocks would need to be stored in either water or air cooled vaults for an undetermined period of time until suitable for disposal. Critics contend that a commitment to this process of vitrification would be folly, as it is not now known how well the glass blocks would age. Some believe that they would crumble in as little as 100 years under radiation and heat.

The feasibility of ocean and sea bed disposal, as a permanent solution to radioactive waste, appears to be limited by the necessity/

27. Taken from Michael Heseltine's testamony before the House of Commons on July 24, 1979, published by the Department of Energy.

necessity of an absolute guarantee regarding the integrity of the container. With the corrosiveness of sea water and the current state of disposal technology, such a guarantee is not possible. Additionally, canisters placed in the thick clay of the ocean would be subject to other uncertainties - such as sediment behaviour and thermal currents - not to mention the risks involved in extended sea transport and the problems of placing the canisters in deep water. The Royal Commission on Environmental Pollution's recommendation of disposing vitrified waste in 1,000 meter deep holes, drilled into stable areas of the bed beneath the deep ocean (4,000 meters), appears to be unworkable as well. Current belief is that containers placed in this manner would actually be drawn down into the earth by plate movement.

Permanent disposal into Antarctic ice, even if it were not forbidden by the Antarctic Treaty of 1959,[28] is likewise not feasible for a number of reasons. Foremost among these is the fact that the ice sheets are relatively young - most of the ice having been deposited less than 100,000 years ago. Also, the ice sheets are known to undergo surges of rapid movement about every 10,000 years. Critics argue that the heat given off by waste containers might even trigger such a surge. In addition, placement in an environment in which human activity is difficult and severly limited, would be hazardous and technologically very demanding.

28. Not only does this international treaty forbid radioactive waste dumping on Antarctica, but it is now believed that the authority of the 1958 High Seas Convention could be used to prohibit the transportation of radioactive materials over the seas to Antarctica.

Extraterrestrial disposal would be extremely risky, due to the possibility of space vehicle malfunction and the re-entry of waste packages into the atmosphere. Moreover, such a method of waste disposal would be cost prohibitive, calculated to be in excess of $2,000 per kilogram of waste.

The final proposal for permanent waste disposal, the utilization of geological formations on land, appears to be the most promising alternative so far. The most secure suggestion to date involves the placing of waste at the bottom of deep holes (10-20 kilometers), with the hole being subsequently re-filled. It is believed that the waste would eventually melt and become pare of the stable rock structure deep in the earth's mantle. Unfortunately, the technology required for this method is beyond present capabilities. Additional drawbacks to such deep holes are the tremendous expenses that would be involved, and the irretrievability of the waste once disposal is accomplished. Other less secure, but more accessible, geological formations which have been suggested as possible waste repositories include bedded salt, granite deposits, some shales, and metamorphic rock. Among these, bedded salt is generally considered to be the most ideal. However, a major deficiency of salt repositories is the presence of brine, which would tend to collect around hot canisters and eventually erode them. Advocates of the salt method contend that the collection of brine could only occur from ground water intrusion. This, they claim, can be avoided through the careful selection of prospective sites. Critics argue that the required integrity of salt repositories is beyond human decision-making. They point out that even such things as past exploratory drilling for oil in bedded salt, where frequently no record was made/

made of the location of the holes, seriously compromise the integrity of any prospective repository. Critics also point to the unsuccessful efforts in the past to select suitable salt repositories, as an indication of the futility of such efforts. Salt advocates counter-argue that the stability of salt formations and their relative isolation from ground water make them the most ideal option yet, and that further investigations as to their worth as long-term waste repositories should be made.

The importance of a secure, stable waste disposal method cannot be over-stressed. The risks of repository failure due to natural phenomena - such as water contact, earthquake, meteorite impact, and explosion of gasses trapped or generated in the repository - and human intrusion or disruption must be carefully considered. Of course, until an adequate solution to the disposal problem is found, the short-term management of waste will continue to be a very serious potential health problem. The conclusions of the Royal Commission on Environmental Pollution were stated very clearly on the whole topic of waste disposal; 'There should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived, highly radioactive waste for the indefinite future.'[29]

29. Sixth Report of the Royal Commission on Environmental Pollution, Nuclear Power and the Environment (HMSO, September, 1976), p. 131.

NUCLEAR PROLIFERATION

One of the major consequences of the widespread use of nuclear power is the likely increase in the number of countries that will gain access to the material and technology for producing nuclear weapons. It appears to be generally believed that of the nineteen nations currently in possession of operational nuclear reactors, thirteen have not yet developed nuclear weapons. By the mid-1980s, this number of non-weapon, nuclear states is expected to reach into the thirties. Advocates of the expansion of nuclear power claim that the network of international agreements and safeguards, worked out since the end of World War II, will adequately deter nuclear weapons development by these nations. A similar claim, often made by the nuclear power industry, is that the authority of both the Treaty on the Non-Proliferation of Nuclear Weapons and the International Atomic Energy Agency will continue to provide adequate reassurance to states willing to forego the development of nuclear weapons. Nuclear supporters contend that current non-proliferation arrangements constitute a bargain between weapon states and non-weapon states, with the former promising safeguards and access to nuclear power and the latter renouncing nuclear explosives. They also argue that there is a world-wide consensus that the spread of nuclear weapons is dangerous. For support, they point to the broad acceptance of the 1963 Limited Test Ban; to the co-operation of first, second, and third world nations with the nuclear safeguards proposed by the International Atomic Energy Agency; and to the working coordination of the London Suppliers Group[1] with the objectives of the Treaty on the Non-Proliferation of/

1. The London Suppliers Group is an informal group of nuclear exporting states which meet regularly to coordinate their export and safeguard policies.

of Nuclear Weapons. Critics of the expanded use of nuclear power, however, contend that it is irrational to expect anything other than a proliferation of atomic weapons, given an increasing use of highly enriched uranium and an increasing availability of separated plutonium. They argue that at international tension points, where rival states confront each other, if only one of these states develops nuclear weapons, a chain reaction will probably follow. Critics also point to the fact that one 1,000 MW nuclear reactor annually produces enough plutonium for about ten good sized atomic bombs. Evidence for this argument against the spread of nuclear power is seen coming from the successful Indian nuclear weapons test of 1974.

Two other particularly distrubing aspects of the proliferation of nuclear technology is the risk of nuclear terrorism and the associated risk of the creation of police states to foil terrorist attempts. While the likelihood of these risks is impossible to determine, their potential development must be carefully considered in the assessment of nuclear power.

Proliferation

Nuclear proliferation is defined within the context of Article II of the Treaty on the Non-Proliferation of Nuclear Weapons. That article clearly states that non-nuclear weapon nations are not to 'manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices'.[2] The treaty took effect on March 5, 1970. Four years later, on May 18, 1974, India detonated a nuclear device. Even/

2. World Council of Churches, 'Ecumenical Concerns in relation to Nuclear Energy', Anticipation, No. 26, June 1979, pp. 42-43.

Even though this was billed as a 'peaceful' explosion, and India was not a party to the non-proliferation treaty, it did constitute overt nuclear weapons proliferation. A less conspicuous form of proliferation could be the development or acquisition of atomic devices without testing. It has been alleged that Israel, for example, may have some assembled or unassembled nuclear weapons that have never been tested. Nevertheless, with India's successful detonation the world clearly entered what Eugene Rabinowitch, editor of the Bulletin of Atomic Scientists, called 'the second atomic age - the age of proliferation'.[3]

Although the spirit of non-proliferation appears to be endorsed by the majority of nuclear states, its support is incomplete and conditional. Possible motives for the development of nuclear weapons could be increased prestige and status, or a chance to overcome isolation and insecurity. For whatever reason, the major concern over proliferation is the risk of nuclear war. This risk is the greatest among unstable countries, where there is the added threat of seizure and possible use of nuclear weapons or materials by dissident or rival groups. Another fear is the possibility of escalation in the event of a nuclear clash between regional states to which the United States and the Soviet Union may have commitments.

Basically, there are three requirements for making a nuclear weapon: uranium, technology, and facilities. Although major deposits of uranium have so far been found in only a few countries, they are widely dispersed in the earth's crust. Unfortunately, only a small amount of uranium is needed for a weapons programme, and nearly every/

3. Robert Jungk, The Nuclear State (John Calder Publishers Ltd., London, 1979), p. 91.

every nation in the world has access to such an amount. While uranium availability has been a negligible factor in the development of atomic bombs, the necessary technology and trained personnel have been limiting concerns. With the continued expansion of nuclear research and power programmes, though, the detailed information on isotope separation and bomb design will undoubtedly become accessible to any nuclear state. Already, a twenty-two year old college student, Dimitri Rotow, has demonstrated on paper how a functional nuclear weapon can be designed and constructed by using only published and widely available nuclear literature.[4] Another limiting factor in the developments of nuclear bombs has been the availability of nuclear weapons facilities. Presently, atomic bombs can be made from either highly enriched uranium, or plutonium. While new methods of enrichment are currently being developed, the standard gaseous diffusion plants cost tens of millions of pounds to build, and consume great amounts of electricity. Centrifuge and laser separation may be available in this decade or next, and would apparently require less capital and electricity. The process to separate plutonium from spent fuel elements appears to be much simpler than uranium enrichment and, according to Amory Lovins, is 'well known'.[5] A similar opinion as to the relative ease of developing plutonium separation, was given by the Royal Commission on Environmental Pollution when it stated, 'We have been impressed and disturbed by the extent to which information on this topic is now/

4. Ibid., p. 109.

5. Amory Lovins, Soft Energy Paths (Penguin, Harmondsworth, 1977), p. 181.

now available in open technical literature'.[6] The prevention of the development of plutonium separation facilities has thus become an urgent task of nuclear power opponents in order to curb the spread of, and access to, nuclear weapon technology.

Alternative methods to the acquisition of nuclear weapons include the use of special facilities designed for the production of enriched uranium or plutonium for weapons; clandestine diversion of weapons material from nuclear, fuel cycle facilities; overt use of weapon materials in disregard of international agreements; fabrication of 'peaceful' nuclear weapons using materials from the previous categories; and either the outright seizure, purchase, or gift of functional nuclear weapons.

It appears that there are no countries in the world today that are explicit aspirants for nuclear weapon status. Brazil and India, the major non-weapon nuclear powers which are not party to the non-proliferation treaty, have stressed the peaceful intent of their nuclear programmes. Israel's official position is that it will not be the first to introduce nuclear weapons into the Middle East. Various insecure nations, such as Turkey, Pakistan, Taiwan, and South Korea, while having indicated circumstances in which recourse to nuclear weapons would become necessary, have adhered to a policy of non-nuclear arms development as long as United States arms and security backing are available. Of the insecure and status seeking nations, Brazil, India, Iran, and Spain apparently have the earliest option for the/

6. As quoted by Hugh Montefiore and David Gosling (eds.), Nuclear Crisis: A Question of Breeding (Prism Press, Dorchester, 1977), p. 63. See also the testimony given by Sir Richard Doll at the public hearings on CFR-1 as quoted by Montefiore and Gosling (eds.), ibid., p. 64.

the development of nuclear weapons.[7] Other developing countries are probably unlikely to undertake the construction of nuclear weapons throughout the remainder of this century mainly because of the enormous capital costs required.

Critics of the continued spread of nuclear power technology claim that the exporters of this technology do not fully appreciate the complexities of the nuclear issue in the developing countries. They contend that the active promotion of nuclear power, first under the U.S. Atoms for Peace programme and subsequently by the International Atomic Energy Agency itself, has led to unrealistic expectations of benefits among these nations. They say that a 'mystique' of nuclear power, which is not warranted on objective grounds, has been allowed to develop. As prime examples of this 'mystique', they point to questionable gestures such as the offer of reactors to both Israel and Egypt by President Nixon, and argue that a word of caution to potential nuclear states would be more prudent. Critics also point to the fact that nuclear power plants are currently only competitive in large units (1,000 MW), operating at high capacity levels (see the third sub-section of this chapter). Capital cost projections, they continue, plus expectations for plutonium recycle, the breeder reactor, and the peaceful uses of atomic explosives all need to be looked at from a more informed, realistic stance. As Amory Lovins concludes, 'support for (nuclear) technology - as several analysts have suggested, and as a Canadian Nuclear Association poll in 1976 confirmed, - is confined/

7. See 'World List of Nuclear Power Plants, December 31, 1975', Nuclear News, February, 1976.

confined increasingly to the uninformed'.[8] Wider knowledge of atomic technology's hazards and uncertainties will, critics claim, shift the present interest in this form of power to other methods, and will decrease the possibility of the proliferation of nuclear weapons.

Nuclear Terrorism

It appears to be increasingly recognised that the threat of nuclear terrorism is very real. Not only is it possible for terrorists to steal nuclear weapons, but, with the worldwide development of nuclear power, the potential threats of terrorists fashioning their own bomb from stolen materials, or using a reactor itself as a radiation weapon have now arisen. In fact, some incidents have already occurred. In 1973, an Argentinian reactor was temporarily occupied by a guerilla group. In 1974, a construction tower was destroyed by an unknown saboteur at a nuclear reactor site in Massachusetts. In 1975, bombs were detonated at two French nuclear plants by unidentified terrorist groups. In that same year Eliodore Pomar, Division Head of the Euratom Atomic Research Institution at Ispra, vanished with radioactive material that he presumably wanted to make available for a neo-fascist insurrection. In 1976, Karen Silkwood, an employee of the Kerr-McGee Plutonium Fabrication Plant, who supposedly had documented evidence of nuclear smuggling, was mysteriously killed just prior to a meeting with a Government official. In 1977, Paul Leventhal reported to the Conference for a Non-Nuclear Future, that the American federal government itself had participated in the illegal dissemination of large amounts of/

8. Amory Lovins, op.cit., p. 219.

of fissile material in at least two instances; - the unexplained loss of 400 pounds of uranium from the NUMEC Depot in Apollo, Pennsylvania, and the disappearance of the S.S. Scheerberg with an unknown quantity of uranium on board. While no terrorists have yet 'credibly' claimed to possess stolen nuclear materials, the possibility is that some do. Even the cautious Office of Technology Assessment in the United States is of the opinion that, 'there are probably groups at large in the world today that possess or could acquire the resources necessary to become nuclear adversaries, if they wanted to'.[9] Certainly the fuel requirement would be a relatively insignificant problem to terrorists, as the American Nuclear Regulatory Commission openly admits that 542 kilograms of enriched uranium and 32.8 kilograms of plutonium were simply unaccounted for between 1968 and 1976. In addition, David Krieger, the former Head of the International Relations Center of California State University, pointed out in 1977 that heart pacemakers contained about a quarter of a gram of plutonium - 238, an amount which could irradiate 37,500 cubic meters with a dose sufficient to kill human beings.[10]

The vulnerability of nuclear installations to the theft or capture of materials by terrorist groups seems to largely depend on the reactor type and the fuel cycle used. It is generally believed that the low-enriched uranium, used in most commercial power reactors, cannot be made to explode or even be fashioned into a weapon. Also, it is basically agreed that theft of spent fuel is unlikely since it is/

9. Office of Technology Assessment, Nuclear Proliferation and Safeguards (U.S. State Department, Washington D.C., 1977), p. 152.

10. Robert Jungk, op.cit., pp. 116-117.

is extremely radioactive and can be handled only with special equipment. Plutonium reprocessing and recycle, however, would definitely increase the opportunities for theft. In reprocessing and mixed oxide fuel fabrication plants, large amounts of plutonium are always on hand. Since wastage, or loss, of around one percent of the plutonium is expected in the reprocessing procedure,[11] it is very conceivable that employees might be able to steal small quantities of the material over an extended period of time without arousing suspicion.[12] Another possibility, of course, is forcible theft by outside groups. According to Josef Kates, the Chairman of the Science Council of Canada, there are several places in Europe where, 'someone armed with a pair of tinsnips can obtain strategic material in strategic quantities because the Governments concerned do not consider the threat credible'.[13] In a similar view, Amory Lovins has cited a British Army estimate that it would take a permanent garrison of between 300 and 400 troops to adequately protect one nuclear power station against small groups of people with light arms.[14] Even more feasible is the theft of plutonium or highly enriched uranium which is being transported between plants. There appears to be nearly unanimous agreement that/

11. Ibid., p. 123; and Amory Lovins, op.cit., p. 182.

12. The first page of the January 27, 1974, edition of the London Observer reported that each year about three percent of the approximately 120,000 people working with U.S. nuclear weapons are relieved of duty as security risks.

13. R.W. Jackson and J.A. Potworowski, eds., A Nuclear Dialogue (Science Council of Canada, Toronto, 1976), p. 31.

14. Ibid., p. 33.

that the transportation of these fuels is the weakest link in the nuclear security network. Critics of an increased nuclear power programme point to the fact that an international, or even a dispersed national, nuclear industry would have large flows of nuclear materials. Terrorists, they argue, would have relatively easy access to highly enriched uranium being shipped from enrichment plants to fuel fabrication plants, to highly enriched uranium or mixed oxide fuel being shipped from fuel fabrication plants to reactor sites, and to shipments being sent from reprocessing plants to storage sites and fuel fabrication plants. Already, several incidents have been reported in the United States where shipments of nuclear materials were misrouted in transit, lost for periods of time, and even delivered to the wrong facilities.[15] The nuclear industry's public response to the possibility of nuclear terrorism is that it has been 'grossly exaggerated'.[16] From the industry's point of view, the major deterrent to terrorist theft of nuclear material is that the radioactivity involved 'carries serious risk to the instigators'.[17] Additional arguments put forth for the case against nuclear terrorism are: that radioactive materials would be ineffective as a blackmail threat, since it is public knowledge that it would take years from the time of radiation exposure to the onset of cancer; and, that mass indiscriminate murder would not help terrorist causes, since these depend heavily on public/

15. W. Epstein, The Last Chance, Nuclear Proliferation and Arms Control (Free Press, Riverside, New Jersey, 1976), p. 49.

16. Montefiore and Gosling (eds.), op.cit., p. 72.

17. L.G. Brookes, 'The Plain Man's Case for Nuclear Energy', Atom, No. 234, April 1976, p. 12. This position, however, seems to contradict the nuclear industry's assertion during the CFR-1 public hearings that nuclear materials even as toxic as plutonium can be hand-held.

public sympathy.[18]

To construct a nuclear weapon, a terrorist group would have to obtain either plutonium or highly enriched uranium. The plutonium would have to be obtained in the form of metal or plutonium oxide since the separation of plutonium from spent fuel would almost certainly be beyond the capabilities of a small group. As pointed out by Jan Prawitz, the Special Assistant for Disarmament to Sweden's Minister of Defence, separated plutonium is only accessible in commercial channels because plutonium is presently reprocessed and recycled.[19] In the absence of this recycle process, the accessibility to plutonium would not exist. Obviously, the success of a terrorist group's attempt to construct an atomic weapon would necessarily depend on the technical skills of the group. It appears to be generally accepted, however, that the relatively few fabrication problems encountered in the construction of a 'simple' bomb, containing sub-critical masses of highly enriched uranium, could feasibly be overcome by a terrorist organisation.[20] The least complex design is the so-called 'gun' design, where two sub-critical masses are blown together by gun powder within a container similar to a gun barrel. Such a weapon might have a yield equivalent to ten kilotons, or ten thousand tons of TNT.[21]

18. Margaret Maxey, 'Nuclear Energy Debates: Liberation or Development', Christian Century, No. 24, July 21-28, 1976, p. 658.

19. Jan Prawitz, 'Is Nuclear Power Compatible with Peace?', John Francis and Paul Abrecht (eds.), Facing Up to Nuclear Power (St. Andrew Press, Edinburgh, 1976), p. 103.

20. Robert Jungk, op.cit., p. 109.

21. This compares with a yield of ten tons of TNT given by the largest conventional bombs used in World War II.

Attacks on nuclear power plants could range from symbolic acts, perhaps even by dissatisfied employees, to terrorist seizure of a reactor. While it is doubtful that a symbolic possession of a reactor would lead to a major radioactive release, the seizure of a reactor by a terrorist group could result in core meltdown and a large release of radioactivity. While other dangers of attack on the nuclear fuel cycle are conceivable, such as an attempt to disperse spent fuel at storage sites, the consequences of these would probably be considerably less severe than from the misuse of a reactor. The nuclear power industry tends to regard this hazard of reactor misuse as extremely slight. The British Government's response to this issue, for example, is that 'By giving careful attention to security considerations at the design stage of nuclear installations, we could ensure that its availability in an accessible form remained severely restricted'.[22] Nuclear power critics argue that while it is true that safety features reduce the likelihood of a successful terrorist attack, they cannot reduce it to an inconsequential level without making nuclear power cost prohibitive. The pro-nuclear camp counter-argues that the technical sophistication and high degree of knowledge required by a commando group for a successful mission makes attacks on reactors highly unlikely. Critics answer that the flow of personnel through military nuclear programmes and the growing civilian nuclear industry provide a large pool of nuclear experience from which terrorists could seek assistance. They also argue that reactor employees held as hostages could be forced to assist their captors.

22. Secretary of State for the Environment, Nuclear Power and the Environment, (HMSO, May, 1977), p. 11.

The technical problems involved in blowing up a reactor appear to be much less complex than those in designing or constructing a nuclear weapon. Explosives carried into a reactor could easily rupture the main inlet pipes for essential cooling water, destroy safety equipment, and damage the primary containment facilities. Nuclear advocates contend that yet another serious deterrent to nuclear sabotage is the likelihood that the terrorists would be killed or captured during the operation. They claim that once having initiated a core meltdown, the terrorists would either be the first victims of prompt radiation or would face likely capture if they tried to escape. Critics point to the recent upsurge in the size, sophistication, and determination of terrorist groups around the world, and argue that any conceivable terrorist act must not be underestimated.

One other disputed point regarding nuclear terrorism is the manner in which a nuclear reactor can be misused. There appears to be a general consensus that a large release of radioactivity, resulting from a core meltdown, is a definite possibility. If terrorists succeeded in this kind of an operation, the consequences would be like those estimated for plant accidents already discussed in an earlier section.[23] A potentially greater hazard is the manipulation of a reactor's core to produce a nuclear explosion. Although the nuclear industry denies that such a thing is possible, critics disagree, particularly with regard to the fast breeder reactor. The Friends of the Earth, for example, have published a memorandum by Dr. Stephen Hanaver, one of the/

23. Although some critics maintain that more severe consequences are possible through sabotage, since if containment is breached at the outset as part of the attack, more radioactivity would be released.

the Senior Reactor Safety Experts of the U.S. Nuclear Regulatory Commission, which draws attention to 'the unresolved problem of a possible core nuclear explosion in a fast reactor'.[24] Additionally, it was primarily to this risk of reactor misuse that Sir Brian Flowers addressed himself while participating in the National Energy Conference in June, 1976. Pinpointing the hazards of nuclear terrorism, he said, 'We believe that nobody should rely for something as basic as energy on a process that produces in quantity a by-product as dangerous as plutonium.'[25]

Security Measures

Many methods for upgrading the security of nuclear facilities have been suggested, both within and without the nuclear industry. Some are technical improvements - tighter accountability of nuclear materials, and stronger defence measures for possible targets in the fuel cycle - and some involve improved security procedures and institutional rearrangements. One proposal, put forth by the U.S. National Regulatory Commission, is to 'spike', or attach highly radioactive emitters, to material shipments and to certain areas in nuclear plants to discourage attempt at theft. Critics of this type of security measure point out that not only would such a system be extremely costly and hazardous to workers, but it would also pose a serious hazard to the public in cases of accidents. Other security/

24. Montefiore and Gosling (eds.), op.cit., p. 44.

25. As quoted by John Habgood, 'The Proliferation of Nuclear Technology', Anticipation, No. 24, November, 1977, p. 35.

security measures, such as more frequent and accurate inventory of nuclear materials, and the use of advanced security systems for worker identification and access control have also been considered. Once again, however, the costs involved in any such system advanced so far appears to be a prohibitive factor. Additionally, even the most sophisticated security systems can never be totally reliable. For example, the latest worker identification apparatus - which uses a secret numerical code, a computerised voice print, a handwriting test, and a fingerprint check - still has a failure rate of two percent. Also, there appear to be a few 'bugs' in even this system which need to be 'ironed out'. United States experts admit that 'difficulties arise with foreigners or Americans of foreign origin, who sometimes unintentionally change their intonation; and ... women also cause a certain amount of trouble since their signature always varies slightly'.[26]

The institutional response to terrorism includes preventive measures such as improved guard capabilities at reactor sites, better alerting and intelligence, and quick response to a crisis once it is underway. A proposal put forth by the U.S. nuclear industry, is that security of nuclear plants could be greatly improved by the creation of a centralised nuclear protective force. The advantages, it is claimed, would be uniform training, access to a wide range of weapons when necessary, and a clear conception of mission and responsibility. Advocates of this proposal point to forces such as the existing Atomic Authority Force in Britain and the Executive Protection Service, which protects the White House grounds and foreign embassies in/

26. Robert Jungk, op.cit., p. 122.

in Washington, D.C., as appropriate models. Opponents question the advantages of the creation of such a special police force. They claim that undesirable facets of this type of force would include the infringement on state police powers, the creation of yet another security bureaucracy, and the possible expansion of governmental police powers at the expense of individual civil liberties. Paul Sieghart raised this last issue when he asked, 'Is there a risk that, in trying to avoid the Scylla of nuclear terrorism, we might slip insensibly into the Charybois of a nuclear police state?'[27] Robin Grove-White, of the Council for the Protection of Rural England, answered Sieghart's question in part when he stated at the Public Hearings on CFR-1 that, 'The aggregation of the particular (nuclear security) measures that would have to be taken seems to point in that direction.'[28]

There appear to be three general areas where preventive measures could adversely affect civil liberties. The first is the rights of the employees who work in a nuclear facility. In addition to background security checks and screenings prior to being employed, these individuals may also be subject to unusual surveillance during the course of their employment. The second area of concern is the secret surveillance of members of the public, or possibly of nuclear industry employees who make contact with 'undesirables'. This might involve the use of informers, infiltrators, wiretapping, checking on/

27. Paul Sieghart, 'Nuclear Power: Setting the Scene', The Tablet, August 13, 1977, p. 765.

28. Montefiore and Gosling, op.cit., p. 69.

on bank accounts, and the opening of mail. As stated in the Sixth Report of the Royal Commission on Environmental Pollution, 'No doubt these methods are already applied to certain small groups that are regarded as dangerous, so that their use in relation to the plutonium threat would constitute nothing new in principle.'[29] The problem is the extent to which Government authorities might feel the need for these surveillance methods in a future characterised by large nuclear power usage. According to the Royal Commission, the greatest danger in this regard is the:

> 'Insidious growth in surveillance in response to a growing threat as the amount of plutonium in existence, and familiarity with its properties, increases; and the possibility that a single serious accident in the future might bring a realisation of the need to increase security measures and surveillance to a degree that would be regarded as wholly unacceptable, but which could not then be avoided because of the extent of our dependence on plutonium for energy supplies.' [30]

The final security concern is in regard to the action that would be necessary in either the recovery of nuclear material that was known to have been stolen, or in the investigation of a nuclear crisis. Security action in these instances could range from a limited detention and search of nuclear employees; to a national search, resulting in the warrentless surveillance, forced education, and detention and interrogation without counsel or probable cause, of hundreds or thousands of citizens. Even after such a crisis has passed, there is the danger that some of the tactics employed during/

29. As quoted by Montefiore and Gosling, op.cit., p. 67.

30. Ibid.

during the crisis might be carried over into routine operations. Critics of the nuclear industry claim that the likelihood of this tendency would particularly be increased if there arose strong public sentiment that such a crisis should never be allowed to happen again, or a widespread fear of society's vulnerability to nuclear terrorism. An example of this kind of fear is apparent in Professor Saperstein's comment in the Bulletin of Atomic Scientists that 'The establishment and toleration of a new inquisition is essential and indispensable for the protection of mankind's physical health ... in view of the hazards associated with nuclear energy'.[31] Justification of surveillance of citizens due to the dangers inherent in nuclear development was also argued at the conference on the 'Impact of Intensified Nuclear Safeguards on Civil Liberties', held in October 1975, at Stanford University. A consensus of the conference was that 'the plutonium factor was a first valid justification of the already existing surveillance measures of the state authorities'.[32]

Dr. J. Ravetz, Secretary of the Council for Science and Society, underscored the inflexible nature of institutional response to nuclear terrorism in his submission to the Public Hearings on CFR-1. After noting the 'structural differences' between various risks to society, he explained how the hazards of a nuclear reactor make it completely different from any other human or social creation. He claimed that not only is the 'threat of disaster from the installations ever-present', but the reactor's response to/

31. As quoted by Robert Jungk, op.cit., p. 145.

32. Ibid., p. 135.

to disturbance is 'brittle ... not homeostatic like an organism'. The consequence being that reactor misuse and accidents 'are liable not to be buffered, but to rip through the system to culminate in disaster'.[33] This constant hazard, he concluded, makes nuclear security measures and the vigilance of the nuclear safety staff particularly threatening to society.

A corollary to the security implications of nuclear energy is the necessity of maintaining political stability in nations which operate nuclear reactors. Since the stability required is for the lifetime of nuclear materials and waste products, the political control of nuclear governments must be practically permanent. Critics of nuclear power point to the present political upheavals in the world, and to the relatively short duration of powerful empires throughout human history. They claim that against this background, the notion of creating eternal vigilance and permanent social institutions is absurdly utopian. Richard Falk has put this concern in the following perspective: 'Think how proud we (in the United States) are to be 200 years old, and we've already had one Civil War and participated in two World Wars. Even to be in favour of something one calls a Faustian Bargain suggests either a rather weak capacity for literary extrapolation, or else a pathological compulsion.'[34] The Sixth Report of the Royal Commission on Environmental Pollution was in/

33. British Council of Churches, Public Hearings on CFR-1, December 13-14, 1976, p. 56.

34. Richard Falk, 'Nuclear Energy and World Order', The Nation, March 13, 1976, p. 305.

in apparent agreement with Falk's assessment when it stated that 'We see no reason to trust in the stability of any nation of any political persuasion for centuries ahead'.[35]

35. As quoted by John Foster, Chairman, Plutonium and Liberty (Justice, London, 1978), p. 18.

CHAPTER II

THE WIDER ECOLOGICAL CONTEXT

ENVIRONMENTAL CRISIS

The manifold complexities of nuclear energy form but a part of a much larger issue regarding the use of our planet's natural resources. While it appears to be generally accepted by the scientific community that some sort of environmental crisis does exist, its scope and solution are a matter of lively debate. On the one side are those who warn that the whole delicate and intricately interconnected system on which all life depends is imperilled; that by ignorance and greed man is poisoning his world beyond repair; and that the ultimate day of reckoning is near at hand.[1] On the other side are those who argue that while there are obvious dangers in the current state of environmental affairs, these have been grossly and emotionally exaggerated; and that any problem can be solved with human intelligence and scientific skill.[2] The position of the nuclear power dilemma within this larger debate was well illustrated in the introduction to Only One Earth:

> 'On the very same day we received forceful statements on nuclear power from two nobel laureates ... according to one of them, the text of Only One Earth does not do full justice to the potentialities of nuclear power and greatly exaggerates its threates to natural ecosystems and to human health; In contrast, the other nobel laureate affirms that nuclear power should not be developed at all, because, in his words, it is "utterly inappropriate in the biosphere".' [3]

1. See R.F. Dasmann, Planet in Peril (Penguin, Harmondsworth, 1972); and A Blueprint for Survival (Tom Stacey, Ltd., 1972).

2. See John Maddox, The Doomsday Syndrome (Macmillan Co., New York, 1972).

3. Barbara Ward and Rene Dubos, Only One Planet (Penguin Books, Harmondsworth, 1972), pp. 26-27.

To adequately deal with the far reaching social and technological questions of nuclear energy, one must confront this larger ecological context.

As commonly used today, the term 'ecology' generally refers to that portion of the earth that is capable of supporting life - the biosphere. Despite the relative stability of the earth's natural ecosystem, ecologists tend to emphasise the fragility of this biosphere, and generally portray it as being in a delicate state of balance. One of the factors giving rise to this fragility is the fundamental principle of interrelatedness - everything being related to everything else. Although individual organisms and biosystems may be isolated for purposes of study, ecologists dismiss this particularised and specialised, fragmented approach as not being in accord with the discipline of ecology. What is required, they contend, is a holistic perspective regarding the entire biospheric environment. The earth is seen by ecologists as a single unified system which, except for the constant influx of solar energy, is also a closed system.[4]

This approach to the environment, as opposed to one having a perspective of fragmentation, which is often utilised in environmental problem solving, has also been emphasised by Barry Commoner. He claims that to define the field too narrowly is to take into account only one or two segments of 'what in nature is an endless cycle ... (giving) attention to a single facet of what in nature is a complex whole'.[5] Commoner has also formulated four generalisations which he/

4. Barbara Ward, 'Speech for Stockholm', in Maurice Strong, ed., Who Speaks for Earth? (W.W. Norton and Co., New York, 1973), p. 23.

5. Barry Commoner, The Closing Circle (Alfred Knopf Inc., New York, 1971), p. 180.

he refers to as 'laws of ecology'. The first is that 'everything is connected to everything else'. Part of this notion of interconnectedness is the cybernetic character of ecosystems to control and govern their own cycles. Commoner's other three 'laws' are: 'everything must go somewhere', a simplification of the basic law of physics that matter is indestructible; 'nature knows best', a value statement in favour of natural processes of survival, adaptation, etc., over the manipulative point of view of man's 'improving on nature' through conscious scientific-technological intrusion; and 'there is no such thing as a "free lunch" ', a popularised expression making the point that every gain is achieved at some cost - a particularly vital concept in considering what some critics cite as the 'hidden costs' of nuclear technology. Basically, then, Commoner's perspective is holistic. In fact, he makes the claim that many of the present forms of technology, as well as our scientific disciplines, are ill-equipped to think, plan, and act holistically:

> 'Few of us in the scientific community are well prepared to deal with this degree of complexity. We have been trained by modern science to think about events that are vastly more simple - how one particle bounces off another, or how molecule A reacts with molecule B. Confronted by a situation as complex as the environment and its vast array of living inhabitants, we are likely - some more than others - to attempt to reduce it in our minds to a set of separate, simple events, in the hope that the sum will somehow picture the whole. The existence of the environmental crisis warns us that this is an illusory hope. For some time now Biologists have studied isolated animals and plants, and Biochemists have studied molecules isolated in test tubes, accumulating the vast, detailed literature of modern biological science. Yet these separate date have yielded no sums that explain the ecology of a lake, for instance, and its vulnerability.' 6

6. Ibid., p. 18.

Commoner's analysis is not meant to demean the power of the scientific method, nor to deny the ability of modern science to analyse complicated systems by breaking them into component parts. Rather, his intent is to emphasise the fundamental holistic character of all environmental complexities.

The holistic perspective is the point of view from which this chapter will investigate the major factors of the current ecological crisis. The basic position taken is that due mainly to the interconnected character of all environmental phenomena, the converging problems of over-population and food scarcity, environmental pollution, diminution of wildlife habitat, and depletion of a non-renewable natural resources, plus the myriad other problems brought about by the technological revolution of the last quarter-century, are creating a set of ecological crises of profound proportions.

Over-population and Food Scarcity

If over-population is defined as that condition under which large numbers of people in widely spread geographical areas are insufficiently fed, then the world is currently over-populated. At present, it is estimated that of the earth's nearly four billion people, ten to twenty million die of starvation or malnutrition yearly, 300-500 million are undernourished, and 1.6 billion (more than one-third of the total) suffer from acute protein deficiency.[7] Over-population occurs because while human populations tend to grow exponentially, food/

7. Rene Dumont and Bernard Rosier, The Hungry Future (Praeger Publishers, Inc., New York, 1969), pp. 34-35.

food supplies are limited to arithmetic growth. Additionally, while the rate of growth of human populations continuously increases, the rate of growth of available arable land remains constant. The result is, no matter how slowly human populations expand, if the birth rate exceeds the death rate, then the 'carrying capacity' of the land, or its ability to produce food, must eventually be exceeded. Consequently, it can be reasoned that in those nations where agricultural production and food imports are currently insufficient to sustain their populations, continued population pressures will almost certainly have catastrophic results in the future. As Paul Errington has remarked, 'I confidently expect the troublous aspects of our population situation to be compounded the higher our numbers go, until the laws of life absolutely put a stop to further increase'.[8]

Over-population is not simply a function of food scarcity. Highly industrialised nations in which the rate of population growth is relatively stable, and in which food is abundant, can still be identified as over-populated. For example, while food production may be able to keep up with population growth, the environment may not. Additionally, the inhabitants of industrialised countries generally produce much more wealth, consume more food, demand more goods and services, extract more non-renewable resources from the earth, and create more pollution of all kinds than do the inhabitants of developing nations. Even if wealth were to keep pace with population/

8. Paul Errington, 'Of Men and the Lower Animals', in Paul Shepard and Daniel McKinley, eds., The Subversive Science: Essays toward an Ecology of Man (Houghton Mifflin Co., Boston, 1969), p. 189.

population growth, the capacity of the natural environment to recover from consequent and inescapable degradations cannot likewise increase; it must eventually decrease. While the biosphere is finite, the demands made on it by industrialised nations seem to be unlimited. The number of people in these nations grow annually, and, more important for ecological concerns, the per capita consumption of all manufactured goods also increases yearly. As a consequence, when too many produce and use too much, the condition of over-population is said to exist.[9]

To put this phenomenon more graphically, Robert Rienow has estimated that for each additional number added to the population of the United States, the planet will have to eventually provide: 56 million gallons of water, 21 thousand gallons of gasoline, 10 thousand pounds of meat, 28 thousand pounds of milk and ice cream, 9 thousand pounds of wheat, 100 thousand pounds of steel, and 1 thousand trees. In addition, for each American baby born the planet will have to provide space for 150 thousand pounds of garbage, and 190 thousand pounds of poisons in the air. To these rather sobering statistics it might be worth noting that the population of the United States is increasing by over two million persons per year.[10] In order to gain a more practical appreciation of this phenomenon, a comparison of the rate of energy consumption in India with that of the United/

9. Paul Ehrlich calls this situation 'over-development'. See Dennis Pirages and Paul Ehrlich, Ark II: Social Response to Environmental Imperatives (Freeman and Co., San Francisco, 1974), p. 3.

10. Robert Rienow and Leona Train Rienow, Moment in the Sun (Ballantine Books, Inc., New York, 1967), p. 37.

United States is also worth noting. Garrett de Bell has figures that each person in India uses only 1/83 rd as much power as a citizen of the United States. Since the total population of India is roughly two and a half times greater than that of the United States, its total consumption of energy, in a global economy of fairness, ought to be proportionally two and a half times as great. However, India's total energy consumption is, in fact, barely 1/33 rd of that of the United States.[11] Such wide discrepancies in per capita rates of energy consumption is one of the factors that has generated a considerable amount of unrest among Third World nations. This unrest was particularly obvious in the positions taken by these nations at both the World Food Conference held in Rome in 1974, and the World Conference on Science and Technology for Human Development held in Bucharest in 1974. As convincingly stated at both of these conferences, the discrepancy factor is made particularly acute when the developed nations insist that the underdeveloped countries enact measures to curb their population growth, and redirect their 'rising expectations' for an improved standard of living. Latin American economist Joao De Araujo Castro forcefully argued this case when he stated that the 'implementation of any worldwide environmental policy based on the realities of the developed countries tends to perpetuate the existing gap in socio-economic development between developed and developing countries and so promote the freezing of the/ present international order'.[12]

11. Garrett de Bell, ed., The Environmental Handbook (Ballantine Books, Inc., New York, 1970), p. 70.

12. Joao De Araujo Castro, 'Environment and Development: The Case of the Developing Countries', in David Kay and Eugene Skolnikoff, eds., World Eco-Crisis: International Organizations in Response (University of Wisconsin Press, Madison, 1972), p. 237.

Population increase, of course, is a factor of both birth and death rates. Nearly all population analysts appear to be in basic agreement that, in terms of a rapidly expanding population, Third World nations have been the somewhat dubious beneficiaries of modern health measures and advanced medical technology. For example, the medical victories over malaria, yellow-fever, smallpox, cholera, and various other diseases - particularly those affecting infant mortality rates - have been instrumental in the 'plunges in death rates throughout most of the underdeveloped countries. In the decade 1940-1950 the death rate declined 46 percent in Puerto Rico, 43 percent in Formosa, and 23 percent in Jamaica'.[13] It is a tragic irony of current history that the so-called 'miracle drugs' and mass immunisations, which have greatly reduced human suffering, have extended human life expectancy, and have made it possible for people to be more healthy, have also unwittingly disrupted some of the 'natural' checks and balances controlling population growth. Death rates have been sharply reduced; birth rates remain largely unchanged. As is the case with many of the technological and environmental problems confronting modern society, man plays the roles of both villain and saviour.

Environmental Pollution

The pollution of the earth's water, air, and soil is perhaps the most immediate visible dimension of the present environmental crisis. As has been reported by orbiting astronauts, the only two traces of/

13. Paul Ehrlich, The Population Bomb, Rev. Ed. (Ballantine Books, Inc., New York, 1971), p. 16.

of man on the planet from the perspective of space are the great wall of China and air pollution.

The pollution of the air, formerly confined to cities with heavy industry, is now virtually worldwide. Meteorologists, as well as the astronauts, lament the 'nebulous veil of air pollution encircling the entire earth'.[14] The figures of air pollutants are staggering. For example, in the United States, before laws governing the emissions from automobiles went into effect in 1973, motor vehicles annually emitted 66 million tons of carbon monoxide, 1 million tons of sulfur oxide, 6 million tons of nitrogen oxide, 12 million tons of hydrocarbons, and 3 million tons of particulate matter into the atmosphere. Though restrictions on emissions are currently in effect, the escalating number of internal-combustion vehicles keeps the total tonnage of emissions as high as before the controls. United States industrial emissions, of which the principal sources are iron and steel mills, petroleum refineries, chemical plants, and pulp and paper mills, total over 2 million tons of carbon monoxide, 9 million tons of sulfur oxide, and 1 million tons of hydrocarbons annually. To these must be added 12 million tons of carbon monoxide, sulfur oxide, hydrocarbons, nitrogen oxide, and particulate matter resulting from the heating of residences and offices, and from municipal-industrial-private trash burning. The total annual yield from the United States alone is over 200 million tons of noxious pollution into the atmosphere. This equates to between two-thirds and three-quarters of a ton of air pollution for every person living in the United States.[15]

14. Paul Ehrlich and Anne Ehrlich, Population Resources and Environment, 2nd ed., (Freeman and Co., San Francisco, 1972), p. 207.

15. Ibid., p. 147.

Two particular worrisome problems associated with air pollution, and of special concern to environmentalists, are temperature inversions and the greenhouse effect (see Chapter One). In a temperature inversion, when surface air is trapped beneath a layer of warmer air, pollutants are prevented from being dispersed into the upper atmosphere. This can raise the concentration of pollutants, especially carbon dioxide, to dangerous levels - leading to respiratory ailments and, perhaps, death.[16] The greenhouse effect, where high levels of atmospheric carbon dioxide absorb ultraviolet solar energy, results in the heating up of the earth's atmosphere. As discussed in the second part of chapter One, even a temperature rise of only two degrees fahrenheit would initiate a melting of the polar ice caps. It appears to be generally estimated that the level of carbon dioxide in the atmosphere has risen from 190 parts per million (ppm) to 330 ppm during the twentieth century. The principal source of this dramatic increase in atmospheric carbon dioxide has been the combustion of fossil fuels in automobiles and in furnaces.

Another form of air pollution has been by chlorofluoromethane gasses, which are used in refrigerants and aerosol propellants. It is feared that these gasses can destroy the earth's ozone layer, which acts as a protective shield against the sun's intense ultraviolet radiation. Although the use of some aerosol propellants have been banned in many countries, the unrestricted use of refrigerants continues. Perhaps the most alarming aspect of this hazard is the timelag involved; for even if all chlorofluoromethanes were banned/

16. Richard Wagner, Environment and Man (W.W. Norton and Co., New York, 1971), p. 185.

banned from use immediately, it would still take several decades for what has already been dispersed to reach the stratosphere and react, to a potentially dangerous degree, upon the ozone layer.[17]

The release of sewage, both raw and treated, into rivers, streams, lakes, and seas is yet another form of pollution which well illustrates the ecological rule that with pollution, quantity is quality. Here again, the volume of the pollutants being dumped into the environment is staggering. For example, New York City alone discharges over 200 million gallons of waste sewage into the Hudson River daily.[18] Compounding the problem of this huge volume of waste, is the fact that roughly 40 percent of the world's municipal sewage-treatment systems are out-dated and inadequate. It has been estimated that in the United States, one thousand communities served by municipal sewage systems are annually added to the list of those which have outgrown their treatment systems.[19]

Even greater in volume than municipal sewage systems are industrial wastes, which contribute 60 percent of all water pollution in the United States. Over 300 thousand water-using industries discharge effluents such as lead, detergents, sulfuric acid, hydrofluoric acid, phenols, benzenes, and amonia into American waterways. Through 1972, in fact, the meat-packing industry of the United/

17. For a thorough discussion of the chlorofluoromethane hazard see William Ophuls, Ecology and the Politics of Scarcity (W.H. Freeman and Co., San Francisco, 1977), p. 108.

18. Paul Lutz and Paul Santmire, Ecological Renewal (Fortress Press, Philadelphia, 1972), p. 39.

19. Philip Noble and John Deedy, eds., The Complete Ecological Fact Book (Doubleday and Co., Garden City, N.Y., 1972), p. 222.

United States Midwest discharged animal wastes - including intestines, grease, and paunch manure - directly, without treatment, into the Missouri River.[20] Industrial operations are the source of varying forms of pollution: lead, mercury, phenol, and sulfur compounds are all toxic to aquatic organisms. Other effluents change the PH of the water (the degree of acidity of alkalinity). One of the most serious threats to the hydrosphere has been the indiscriminate pumping and piping of chemicals into rivers and lakes. For example, it has been estimated that in the period from 1958 to 1972 alone, over 50 million fish died in the Mississippi River from various sorts of industrial poisons.[21]

The properties of clorinated hydrocarbons make them particularly dangerous at every point of the hydrospheric cycle. Residue from their use in agriculture filters into rivers, lakes, estuaries, and oceans. Their inherent stability insures their long residence in the ecosystem. The average half-life for DDT, in fact, is more than a decade. Additionally, the 'mobility' factor of these hydrocarbons is another property that lends to their wide distribution. Paul Ehrlich records that DDT has been discovered in the tissues of frogs living high in areas of California's Sierra Nevada mountain range that have never been sprayed with DDT. Further, Ehrlich continues, 'DDT codistills with water; when water evaporates and enters the atmosphere, DDT goes with it'[22] to return in the rains. Chlorinated hydrocarbons/

20. Lutz and Santmire, op.cit., p. 40.

21. Frank Graham, Since Silent Spring (Houghton Mifflan Co., Boston, 1974), p. 103.

22. Ehrlich and Ehrlich, op.cit., p. 207.

hydrocarbons have one further characteristic - they become concentrated in the fats of organisms. Given the nature of food chains, their concentration is quite low in the smaller animals and fish. However, the level in larger predators, as well as in man who consumes these predators, tends to be quite high.[23]

Crude petroleum and poisons of the 'organo-phosphate' and 'carbamate' varieties can also be added to the chlorinated hydrocarbons to yield a total of well over one thousand different chemical products which have been indiscriminately dumped into the world's waters. Richard Falk estimates that the amount of petroleum either leaked, dumped, or pumped into the seas is over one million tons per year.[24] Not included in this total are spectacular tanker accidents which are likely to occur more frequently as more oil is transported by sea. The 'organo-phosphate' and 'carbamate' compounds are found in products as diverse as pesticides, paints, and floor waxes. Although it is illegal in many countries to uncritically pollute the environment with these toxic chemicals, the sheer volume of past pollution, plus the residual effects of chlorinated hydrocarbons yet to be broken down, continue to make water pollution a major concern.

Pollution of the soil is nearly always the result of misuse and overuse of chemical pesticides, herbicides, fungicides, and fertilizers. These are substances not found in nature which degrade the soil both by direct pollution and by reducing the capacity of the/

23. Ibid., p. 204.

24. Richard Falk, This Endangered Planet: Prospects and Proposals for Human Survival (Random House, New York, 1971), p. 205.

the soil to produce its own fertilising humus and natural defences against bacterial and viral diseases and insect infestations. And, of course, the soil is polluted biologically - not to mention aesthetically - by depositing solid waste on it, and burying waste under it.

There appears then, to be at least three hard lessons of ecology to be learned from the various forms of environmental pollution. The first is the principle of interrelatedness which is clearly demonstrated by the fact that pollutants introduced into either water, air, or soil eventually appear in the other two. Because of interdependence, pollution will not stay put. The entire biosphere becomes host to pollutants discharged in originally circumscribed localities, and, in the case of relatively stable compounds such as DDT, their damage is continually compounded rather than diminished as they work their way through the soil, the atmosphere, the seas, and, eventually, various plant and animal species.

A second lesson to be learned is that in the case of pollution, quantity is quality. All natural ecosystems possess remarkable abilities of self-cleansing. But each has a threshold beyond which these self-cleansing mechanisms become overloaded and disfunctional. The problem of threshold is greatly enhanced, however, when pollutants are not natural substances. In this event, the threshold is breached instantly. There is simply no way for ecosystems to rid themselves of substances with which they have not evolved, and for which, therefore, they have no cleansing mechanism.

The final lesson follows from the other two. Any substance not found in nature which is introduced into nature, will be damaging to it. The long, slow process of natural selection has fitted each ecosystem for the decomposition and reabsorption of organic substances/

substances produced by it. As Barry Commoner has stated: 'One of the striking facts about the chemistry of living systems is that for every organic substance produced by a living organism, there exists, somewhere in nature, an enzyme capable of breaking that substance down. In effect, no organic substance is synthesised unless there is provision for its degradation; recycling is therefore enforced'.[25] Any man-made substance, therefore, is unlikely to be absorbed by a natural system for which the substance is not fitted, and the substance will accumulate undegraded; causing damage to the balance of the ecosystem, while, at the same time, endangering other systems to which the substance then spreads. The relevancy of this lesson to the creation of stable, relatively timeless radioactive waste materials from nuclear technology is obvious.

Diminution of Wildlife Habitat

The modern acceleration of land clearance has had the effect of destroying wildlife habitat at an enormous rate. Clearing land for cultivation, for industrial development, for commercial and residential construction, for lumbering, strip mining, and oil exploration has accelerated with the demands of increased populations for more of everything. Keeping pace with this acceleration has been the development of technological means with which even larger areas can be cleared ever more quickly. As reported by Frank Elger, 'our earthmoving machinery is becoming increasingly powerful, with shovels now commanding 18 thousand horsepower. These goliaths are taller/

25. Commoner, op.cit., p. 40.

taller than a 20-storey building, longer than a city block, and wider than an eight-lane highway, with a digger that can dig 200 thousand tons of earth a day'.[26] The increasing use of this incredibly powerful technology on a global scale has led Colin Bertram to conclude:

> 'All in all, the prospects for other large vertebrates, and for small ones too - to say nothing at all of other animals and plant communities - could scarcely be worse than they are today in the face of overwhelming competition from humankind. The force of competition increases geometrically - each year the rate of increase itself increases - because that is what man's numbers do.' [27]

In the United States, 126 species of reptiles, birds, and mammals are presently listed as being in imminent danger of extinction, with more than 26 thousand species of plants being considered for similar listing.[28] This is largely a product of the fact that over one million acres of wildlife habitat are annually destroyed in the United States.[29] In Africa and Asia, the lion, tiger, cheetah, leopard, elephant, rhinoceros, and gorilla are all disappearing at the hand of not only hunters and poachers, but also through agricultural development which is not even keeping up with the needs of burgeoning human populations.

Plant populations, particularly trees, are also being destroyed at rates detrimental to environmental fitness. This destruction has had/

26. Frank Elger, 'Pesticides in our Ecosystem', in Shepard and McKinley, eds., op.cit., p. 252.

27. Colin Bertram, 'Man Pressure', ibid., p. 213.

28. John Dunn, 'Wildlife - Causes for alarm', National Wildlife, No. 14, February-March, 1976, p. 18.

29. Bob Strohm, 'For Our Quality of Life: A Steady Downhill Slide', National Wildlife, No. 12, February-March, 1974, p. 8.

had two insidious effects. One is that the benefits of photosynthetic action are lost with the plants. Of all the pollutants man dumps into the atmosphere, the largest in volume are particulate matter and carbon dioxide. Since green plants convert carbon dioxide into usable oxygen, any degradation of plant communities reduces the capacity of plant photosynthesis to cleanse the atmosphere. The second effect is that any significant reduction in the diversity of naturally occurring species in a given ecosystem will weaken the resistance of that system to imbalance and collapse.

> 'As incomplete as our knowledge may be concerning the operation of the natural systems that support human life, one cardinal principle now seems clear: the ability of ecological systems ... to persist and perform their function in the face of the inevitable environmental change is related to the complexity of those ecosystems. The more species that flourish and share substantially in the energy that flows through an ecosystem, the more stable that system is likely to be ...' 30

Conversely, the more simplified the system is forced to become, the more prone it will be to the ravages of plant diseases, insect infestations, chemical toxicity, and over-intensive cultivation. It is generally claimed that as much as one-third of the earth's plant cover has already been eradicated by human action. More importantly, perhaps, is the fact that this destruction is continuing at an exponential rate.

Depletion of Natural Resources/

30. Paul Ehrlich, 'How Long can the Planet Support Us?', International Wildlife, No. 4, March-April, 1974, p. 22.

Depletion of Natural Resources

As previously discussed in the economics section of Chapter One, many of the resources produced in the earth over enormous stretches of geologic time are being extracted and consumed in a geologic instant. Like the wildlife species exterminated by man, once these resources are gone, they are lost to the earth for all time. In addition to the rapid depletion of natural gas and oil, it has been estimated that the United States' supplies of iron will be exhausted in 72 years; copper in 38; zinc in 28; lead in 27; and bauxite in only 5 years.[31] However, more significant than the utter depletion of these resources is the overall effect which resource depletion has on the biosphere. The more resources used, the more pollution expelled into the biosphere. It is not entirely unlikely that future eco-catastrophes, caused by pollution will, through the phenomenon of interdependance, chain react into much greater disasters. Social, political, and economic disintegration, following close upon the heels of such disasters, may be sufficient to put a halt to heavy industrialisation in one region after another.[32] As stated by Paul Ehrlich, 'ultimately, environmental constraints will probably limit the amount of resources available to man before they are totally exhausted'.[33]

31. Strom, op.cit., p. 9.

32. A more grim picture is painted by Robert Heilbrower in An Inquiry into the Human Prospect (Caldwell and Boyers Publishers, Ltd., London, 1975), chapters 2 and 5.

33. Ehrlich, op.cit., p. 23.

Another far-reaching consequence of massive use of non-renewable resources for the generation of energy is that the more highly industrialised the economy becomes, the lower in the food chain the search for energy takes place. In other words, when energy is tapped close to the top of the food chain, it relies on photosynthetic energy from green plants and from the animals which consume these plants. When energy is tapped lower in the food chain, from, for example, fossil fuels, less energy is consumed by intermediary specias and more is available to man and his machines. The more such energy is utilised, the higher numbers of people which can be supported. Eventually, however, the environmental damage from the use of such energy sources overwhelms the capacity of natural systems to recover. Among other things, this means that by the time these energy sources are exhausted, the pollution caused by their use will have wholly degraded the photosynthetic capabilities of green plants. Having thus exhausted energy at the lowest end of the food chain, man will then be unable to return to even the paleolithic life-style of drawing energy exclusively from the top of the food chain.[34] In this case, the biosphere would be quite as effectively demolished as by a thermonuclear war, and be quite as uninhabitable.

34. The explanation of the relationship of energy to photosynthesis used here comes from Bernd Heinrich, 'The Energy Crisis: A Biological Vantage Point', New York Times, Sunday, November 25, 1973. The conclusions, however, are my own.

ENVIRONMENTAL RESPONSIBILITY

Given the state of the earth's ecological crisis, it is obvious that the cause of the predicament rests with human shortsightedness and/or irresponsible arrogance toward the natural environment. While it can be argued that there are ways in which the processes of nature themselves disturb the intrinsic ecological balance of the planet, the present deterioration of the biosphere is almost exclusively the product of human agricultural and industrial technologies, as developed and practiced by Western-style industrialisation.

Merely two decades ago, it was commonly assumed that the character of Western industrialism was the model of 'progress', and that any nation's degree of 'development' could be judged by how far it had 'progressed' toward the Western goal of industrialisation. In the mid-1960s, however, two major movements of dissent arose which attacked this model of 'developmentalism'. One of them occurred primarily among social thinkers in the Third World, especially Latin America, who began to reject the idea of development for that of liberation. These critics argued that the poor countries were poor not because they were 'underdeveloped', but because they were mis-developed. According to this argument, the ecological crisis is a product of the way in which particularly exploitative classes, races, and nations use and abuse natural resources and available technologies. Technological 'fixes', it was contended, are always in the interests of the powerful and dominant, are always geared to the immediate, and always lead to greater problems at a later date. Out of this basic thesis gradually evolved the notion that the scientific method itself is defective; that because scientific truths/

truths are inherently temporal, a society based on their impermanence will be increasingly led into social relativism and chaos. Science and its technological applications, it was concluded, have to be shunned if an ecological balance is to be restored.

The second movement, which attacked the concept of Western 'developmentalism', arose out of the 'New Age' philosophy in the West, and perceived the ecological crisis as an outgrowth of the Judeo-Christian religious heritage. Spokesmen for this camp, such as Lynn White, Jr., Arnold Toynbee, Theodore Roszak, Jackson Lee Ice, Ian McHarg, and others argued that Western theology is basically ecologically bankrupt; that the biblical anthropocentric-anthropomorphic tradition relegates nature to virtual inconsequence, and allows for its mindless exploitation. These critics identified the roots of the ecological crisis as deeply religious, and they called for the development of a new, Western ethic of conservation that would be totally divorced from the arrogance of the Christian tradition. Only this, they argued, would save the biosphere from total collapse.

While it is not a purpose of this paper to lay the blame of the deepening environmental crisis on any particular ideology, it is worthwhile to critically analyse the hypotheses of these two movements, if only to more clearly understand what is required of the world by way of a solution to the predicament. It is one thing to suggest that Western civilisation change its ways. It is quite another to decide how fundamental these changes are to be, and where, in Western consciousness, they are to occur.

Technological Responsibility/

Technological Responsibility

Barry Commoner has been one of the most persistent in arguing that it is the 'new technology' (that is, technological developments since World War II) that has escalated the environmental damage. Noting that pollution levels have increased by amounts disproportionate to both the increase in population and the growth of gross national products, Commoner has attempted to calculate, in logarithmic terms, the deleterious effects of Western technology:

> 'The logarithm of the increase in population accounts for from 12 to 20 percent of the logarithm of the various increases in total pollutant output since 1976. The logarithm of the affluence factor (i.e. the amount of economic good per capita), accounts for from 1 to 5 percent of the logarithm of the total increase in pollutant output, except in the case of passanger travel where the contribution rises to about 40 percent of the total ... The technology factor - that is, the logarithms of the increased output of pollutants per unit production resulting from the introduction of new technologies since 1946 - accounts for 80 to 85 percent of the logarithm of the total output of pollutants ...' 1

Included in these 'new technologies' is the agri-chemical business, whose pesticides have not proven to be unit-specific - that is, their chemicals and poisons have 'travelled', affecting more than their intended objective. Included also would be the petro-chemical industry, from whose research and production have come, among other things, non-biodegradable plastics. In addition to these, Commoner has enumerated a long list of new products - such as detergents, and higher-combustion engines emitting higher levels of pollution - that/

1. Barry Commoner, The Closing Circle (Alfred Knopf, Inc., New York, 1971), p. 174.

that have contributed to environmental 'disruption' and 'devastation' as a result of the new technologies.[2]

In addition to the obvious increases of effluents - which are products of the consumer revolution, which has accompanied and fueled the technological developments in electronics, transport, and synthetics - there has also been a direct impact of technology on population growth. Cameron Hall has put the case in this fashion: 'The central cause of world population-hunger problems has been the discovery and application of scientific technology in the field of health, which dramatically decreased death rates but did not reduce birth rates.'[3] Hall, of course, is not suggesting a malicious intent by those who utilise these technologies; indeed, it is quite clear that in the case of alleviating diseases, precisely the opposite has been intended. However, the damaging effects of medical technology do contain a lesson concerning the future employment of technologies for short-term goals.

In addition to increased pollution and medical dilemmas caused by advanced technologies, numerous other global problems have been documented as being by-products of the development and utilisation of new technologies. For example, in the instance of technologies being applied to evil purposes, Barbara Ward and Rene Dubos have traced the influence of technology on war - the development of new equipment, new poisons, and even more efficient production methods. In fact, their/

2. Ibid., pp. 138-175.

3. Cameron Hall, Human Values and Advancing Technology (Friendship Press, New York, 1967), p. 13.

their contention is that much of Western technological development since the time of Leonardo Da Vinci can be traced to war-induced inventiveness. For support of their argument, Ward and Dubos cite such things as the nineteenth century demand for accurate firearms, which yielded an industrial evolution of interchangeable parts, high speed lathes, drilling equipment, hardened metals, and new alloys; the development of tanks during World War I, which yielded the farming technology of tractors; and the World War II by-products of chemical pesticides and, of course, the atomic age.[4]

Obviously, problematic by-products can be, and have often been, endemic in the advancement of technological development. Eugene Schwartz, in his critical analysis of the technological process, Overskill, contends that technological developments, or solutions, are actually quasi-solutions to the problems they address. He claims that each 'solution', in fact, leaves a 'residue' of unsolved problems. The causes of this residue, he continues, are 'technological incompleteness' and 'augmentation of the original problem'. Technology is inherently incomplete, he says, because each 'improvement' can always be further refined. An example can be observed in the conversion of fuels into energy - a process which is never 100 percent efficient. Augmentation of the original problem arises, Schwartz claims, because 'a higher-level problem is engendered by the completion of a solution to an original problem, to the extent possible, at which time the general problem demands a different type of solution'.[5]

4. Barbara Ward and Rene Dubos, Only One Earth (Penguin Books, Harmondsworth, 1972), p. 65.

5. Eugene Schwartz, Overskill (Ballantine Books, Inc., New York, 1971), p. 60.

The resulting situation may demand a whole new technology in response. A classic example of what Schwartz means by 'augmentation' was witnessed by the so-called Green Revolution. Here, new hybrid strains of grain were introduced into geographical areas of high-population density and food shortages. To accommodate the new strains, sophisticated fertilizers were also introduced and adequate irrigation systems installed. Unfortunately, it was realised too late that the new strains were inherently more fragile than the traditional ones, because they lacked the variety of possible mutant responses to unsuspected challenges from the environment. Additionally, it was discovered after the fact that this type of agricultural practice tended to be 'mono-cultural', which made the new strains even more vulnerable to specific pests and even slight ecological imbalances. As the Green Revolution progressed, the indigenous, peasant-oriented culture tended to be replaced by large producers, largely because costly heavy machinery was needed to offset the expensive fertilisers and seeds by planting large numbers of acres. Displacement of the peasants to the cities created larger ghettoes, particularly in Calcutta and Bombay, India, and more starvation. As Susan George has concluded, 'where nothing is done to alleviate inequalities, the Green Revolution is guaranteed to worsen them. Peasants are notoriously the most difficult social group to prod into collective action .... because their whole lives, not just their jobs, depend on the local feudal powers. The Green Revolution is increasing their misery ...'[6]

6. Susan George, How the Other Half Dies (Penguin Books, Harmondsworth, 1977), p. 132.

Other dramatic problems caused by the introduction of highly advanced technologies into pre-industrial areas has been well documented by Barbara Ward and Rene Dubos.[7]

Eugene Schwartz has yet a third cause of the residual effects of technological developments which he calls 'secondary effects'. These may be 'expected or unexpected, obvious or hidden'.[8] Such effects have also been noted by others, such as Garrett Hardin who has distinguished between a 'side-effect' (that which has not been foreseen), and a 'flashback' (resulting from a failure to think in terms of the systems involved; for example, the interrelatedness of the environment).[9] An illustration of both Hardin's classification and the secondary-effects category of Schwartz , is the Aswan High Dam project of Egypt. With financial backing coming chiefly from the Soviet Union, the Egyptians dammed the Upper Nile in order to generate electricity, control flooding, and irrigate agricultural areas. However, the plains area, previously fertilised by the Nile's annual flooding, now requires inorganic fertilisation in massive quantities, and is steadily falling victim to salinisation, since it is no longer being silted and drained by flood waters. Furthermore, irrigation ditches built to carry water to the previously dry areas have now become migratory channels and habitats for snails carrying micro/

7. Ward and Dubos, op.cit., pp. 209-220.

8. Schwartz, op.cit., p. 61.

9. Garrett Hardin, 'The cybernetics of Competition: A Biologist's view of Society', in Paul Shepard and Daniel McKinley, eds., The Subversive Science: Essays Toward an Ecology of Man (Houghton Mifflan Co., Boston, 1969), pp. 290-291.

micro-organisms that cause schistosomiasis, a blood disease easily contracted by humans that is characterised by painful and crippling abdominal disorders, and often leads to death among children.[10]

An additional view of Western-style technology, which seems relevant to this discussion, concerns the 'technological fix'. This idea has been articulated by Norman Faramelli, among others, and is a rather naive assumption that 'no matter how badly the side effects of current technology destroy the environment, new technologies will appear that will fully ameliorate the damages'.[11] Technology uncritically applied to 'fix' a problem can be faulted for both its myopia and its narrowness, as well as its ignorance of the inherent complexities of the environment. A society which depends on technology for a 'fix' - not unlike the dependency of a heroin addict - could well be attempting to avoid difficult decisions that are, perhaps, non-technical in character. This point has been convincingly made by the Limits To Growth editors, among others, who maintain that there are problems demanding societal attention, to which there are no technical solutions. Nuclear arms, racial tensions, and widespread unemployment indicate complex challenges which no mere technological adjustment will solve. If, as Donella Meadows has postulated, society continues to refuse to address these larger challenges, 'it may very well be a problem with no technical solution, or the interaction of several such/

10. Ward and Dubos, op.cit., pp. 227-229.

11. Norman Faramelli, 'Ecological Responsibility and Economic Justice', in Richard Sherrell, ed., Ecology: Crisis and New Vision (John Knox Press, Richmond, Va., 1971), p. 37.

such problems, that finally brings an end to population and capital growth'.[12]

These two positions on the belief in technological fixes, are evident in the ongoing debate concerning nuclear energy. While nuclear advocates stress the unlimited potential of advanced nuclear technology to solve the current problems, critics argue for care in the application of any technological remedy, particularly in a field as potentially hazardous as nuclear power. Caution, they contend, is called for especially when the complexities of ecosystems and the technological track record of the past thirty years is taken into account. As a distinct warning to the application of advanced nuclear technology, Raymond Dasmann claims that it has been precisely man's failure to control new power and technologies that have become available to him, that has led to the severity of current environmental problems.[13]

An outgrowth of the use of complex technologies, with their rapidly accelerating pace of change, is what some see as a psychological and social crisis - what Alvin Toffler refers to as a 'future shock'. Toffler's contention is that the 'arrival of the future' will precipitate a 'dizzying disorientation', and a continuing culture shock as people are bombarded by an ever-increasing proliferation of changes in life-style possibilities, technological innovations, and psychological stimuli. His thesis is that the/

12. Donella W. Meadows, et.al., The Limits To Growth (Universe Books, New York, 1972), p. 156.

13. Raymond Dasmann, Planet In Peril (Penguin Books, Harmondsworth, 1972), pp. 12-13.

the future will arrive with ever-increasing speed, and that individuals and societies will have to develop new ways of adjustment in order to avoid the malady of future shock.[14]

Cultural Responsibility

At some point in Western Cultural History, science and technology took on a certain ideological component. According to some, it was this ideological component and not the knowledge nor the skills themselves, which has been at least partly responsible for our present environmental troubles.[15] From this perspective, Enlightenment science, whatever else it accomplished, is seen as having served to widen the perceived gap between man and the rest of nature. As Ian Barbour has pointed out, if nature - after the work of Bacon, Newton, and Descartes - was perceived as mechanical, atomistic, passive, and non-mysterious; then man, by contrast, was seen as rational and purposive, and his history as progressive and perfectable, indeed, as 'the very locus of all meaning'.[16] This ideology of human transcendence over the natural realm, from which man was increasingly presumed to be freed, was not significantly modified by the development of Romanticism, and was greatly enhanced by the rise of the Industrial Revolution - itself an outgrowth of Enlightenment/

14. Alvin Toffler, Future Shock (Random House Inc., New York, 1970).

15. See J. Bronowski and Bruce Mazlich, The Western Intellectual Tradition (Harper and Row Ltd., London, 1960).

16. Ian Barbour, Issues in Science and Religion (Harper and Row Ltd., London, 1966), p. 15.

Enlightenment ideology as much as of Enlightenment science and technology. Consequently, it is concluded by this point of view, it is ideology rather than science and technology which should properly come under fire for our current predicament. This argument also contends that insofar as the eighteenth century development of science and technology can be blamed for the current crisis of the environment, it can only be blamed in its perspective. The scientific conceptions of creaturely interdependence, of ecosystems and the mechanisms of balance and disruption which govern them, of the biotic community as a web - in short, of man's place in and not apart from nature - are new. It cannot be assumed that eighteenth century scientists were omniscient. Nor can they be blamed for falling short of omniscience, thereby salving our own environmental conscience. If science and technology have gotten out of hand, it is argued, it is because our ideological attitudes toward man and nature are largely unchanged from what they were three hundred or more years ago, while the scientific worldview has lept ahead.[17]

Another cultural cause put forth as being responsible for the present ecological crisis is the idea of 'perpetual progress' - another development of Enlightenment science and subsequent industrial revolution technologies.[18] Progress came to mean unlimited material accumulation and spatial expansion. When progress is thus equated/

17. Charles Birch has argued just the opposite to make the same point, namely that scientists are still operating on the theories of a dated mechanistic worldview, See Charles Birch, Nature and God (Westminster Press, Philadelphia, 1965), p. 32.

18. See Bronowski and Mazlich, op.cit., pp. 485-490; and J.B. Dury, The Idea of Progress (MacMillan Co., New York, 1920).

equated with growth; or with the direction ascribed to technological thinking by Jacques Ellul, which is that 'whatever can be done must be done; whatever is possible is obligatory',[19] then a fairly direct correlation can be drawn between the idea of perpetual progress and eventual environmental damage. This idea is still very much with us today. Whether or not it is exclusively Western in origin, it has tended to become internalised, along with industrial development and various attendant consumer goods, by all nations in the process of modernisation.[20] This now global perception of progress as unlimited growth runs counter to the overwhelming fact of absolute environmental limits. Even if the industrialised nations were to outgrow their belief in the goodness of limitless national accumulation and spatial expansion, the developing nations will undoubtedly continue to perceive this ideal of progress as desirable. For the Third World today, progress has come to mean the attainment of acceptable levels of human well-being, and the symbol of physical betterment.

Christian Responsibility

In a recent article, the Christian environmentalist H. Paul Santmire has written:

> 'In the understandable rush to find new ecological insights .... it has been widely assumed that the classical Western theological tradition has had its day, that its storehouses are empty, that indeed the expenditure of its treasures has done nothing than buy us larger and larger shares of/

19. Jacques Ellul, The Technological Society (Random House, New York, 1964), p. 147.

20. Ward and Dubos, op.cit., pp. xi-xviii.

> of ecological disaster. In short, the classical Western theological tradition is ecologically bankrupt.' 21

Santmire refers to this line of thought as 'generally uncritical condemnation', and names it the 'conventional ecological wisdom'[22] - which found its first forceful voice in the historian Lynn White, Jr.

White's initial article on the subject, 'The Historical Roots of our Ecological Crisis'[23] has been hailed by many as a prodigy of historical analysis, and has been reprinted in many scholarly and popular books and journals. The major thrust of White's argument is that 'not only modern technology but also the unhesitatingly exploitative approach to nature that has characterised our culture are largely reflections of value structures emerging from the matrix of Latin Christianity'.[24] This matrix of Latin Christianity is seen by White to include all forms of Christianity except Eastern Orthodoxy.[25] The argument, therefore, tends to be general and diffuse. One can, however, identify two recurring elements of the conventional ecological wisdom. The first is an argument taken from Biblical Scripture, Genesis I, and the other is a comparative approach of the Christian West with either pre-Christian or non-Christian/

21. H. Paul Santmire, 'Reflections on the alleged ecological bankruptcy of Western Theology', Anglican Theological Review, No. 2, April 1975, p. 145.

22. Ibid.

23. Lynn White, Jr., 'The Historical Roots of our Ecological Crisis', Science, CLV, March 1967, pp. 1203-1207.

24. Lynn White, Jr., 'Continuing the Conversation', in Ian Barbour, ed., Western Man and Environmental Ethics (Addison-Wesley Ltd., London, 1973), p. 60.

25. White, 'The Historical Roots of our Ecological Crisis', op.cit., p. 1204.

non-Christian cultures in regard to their perceived relationship with the natural world.

The argument concerning Genesis I is that this chapter of the Bible contains explicit legitimation for man's irresponsible use of nature, and, therefore, that the roots of the current environmental predicament lie in these few relevant lines in this chapter. White presents his understanding of Genesis I in a single paragraph which briefly recounts the order in which God created beings and things, and includes White's condemning conclusion 'God planned all of this explicitly for man's benefit and rule: no item in the physical creation had any purpose save to serve man's purpose'.[26] The rightful subjugation of nature by man has been, he says, an axiom of Western ideology ever since, and it is still 'almost universally held not only by Christian and neo-Christians but also by those who fondly regard themselves as post-Christians'.[27]

As mentioned earlier, White is by no means the only scholar to hold this view. It is echoed in Arnold Toynbee's indictment of the Biblical tradition when he states that the entire Christian doctrine of the relation between God, man, and nature is defined in one sentence within one verse in the Hebrew Bible: 'Be fruitful and multiply and replenish the earth and subdue it' (Genesis1:28).[28] None of the Christian churches, he contends, have moderated this/

26. Ibid.

27. Ibid., p. 1206.

28. Arnold Toynbee, 'The Religious Background of the Present Environmental Crisis', in David and Eileen Spring, eds., Ecology and Religion in History (Harper and Row Inc., New York, 1974), p. 183.

this stance since. 'Their adherents have, with few exceptions, persisted in behaving as rampant Old Testament tribes, now terrifyingly endowed with modern technological knowledge and equipment, and making mischief for the world on a corresponding scale.'[29]

White's argument from Genesis I takes special note of the fact that the Old Testament separates God from his creation. White believes that because the substance of God and nature is not a shared substance in this Scripture, man is instructed to perceive nature as merely a physical entity; useful, but Godless.[30]

> 'A governor of California, like myself a churchman, but less troubled than I, spoke for the Christian tradition when he said (as is alleged), "When you've seen one redwood tree, you've seen them all." To a Christian, a tree can be no more than a physical fact.' [31]

An adjunct to the argument from Genesis I is the assertion that the Bible, by giving man to understand that he is created in the image of God, frees him utterly from his creatureliness. If the Old Testament separates God from creation, it must separate man from the natural realm at the same time, for, as the argument goes, man relates to nature according to the equation: man is to nature as God is to man.

> 'As early as the second century both Tertullian and St. Irenaeus of Lyons were insisting that when God shaped Adam he was fore-shadowing the image of the incarnate Christe, the second Adam. Man shares, in great measure, God's transcendence of nature. Christianity ... not only established a dualism of man and nature/

29. Max Nicholson, The Environmental Revolution (McGraw-Hill Book Co., New York, 1970), p. 264.

30. White, 'The Historical Roots of our Ecological Crisis, op.cit., p. 1205.

31. White, 'Continuing the Conversation', op.cit., p. 90.

nature, but insisted that it is God's will that man exploit nature for his proper ends.' 32.

Ian McHarg, the landscape architect and environmentalist, understands the doctrine of 'imago dei' as an insistance upon the exclusive divinity of man, his independent superiority, his dominion, and his license to subjugate the earth.[33] The logic of this interpretation seems to be that if man is like God, then man (whom Toynbee calls 'God's aggressive licensee'[34]) is somehow duty bound to deliver nature a resounding whack at every available opportunity because God insists on it.

In comparing the Christian perception of the natural world with that of the pre and non-Christian cultures, the advocates of conventional ecological wisdom contend that Christianity's most distinguishing feature is its high regard for nature and the manners it has adopted to manipulate it. Matter, they argue, assumed its all-important place in the Christian tradition when St. Thomas Aquinas focussed his mediaeval synthesis of Greek philosophy and Christian belief on the principles of the separation of subject and object, as previously laid down by Aristotle. The chief characteristic of St. Thomas' philosophy, according to Frederick Copleston, 'is its objectivity rather than its subjectivity. The immediate object of the human intellect is the essence of the material thing, and St. Thomas builds up his philosophy by reflection on sense-experience'.[35] The argument continues that/

32. Ibid., p. 86.

33. Ian McHarg, 'Values, Process, Form' in Robert Disch, ed., The Ecological Conscience (Prentice-Hall International, Inc., Englewood Cliffs, 1970), p. 22.

34. Toynbee, op.cit., p. 14.

35. Frederick Copleston, History of Philosophy, Vol. II (Westminster Press, Maryland, 1960), p. 309.

that this peculiarity of Western philosophical thought has forced Christianity to become uncompromisingly dualistic ever since - forever attempting to join matter and spirit wherever possible. Even in death Christianity is said to not desert the body, as the Christian belief in life after death is regarded in very physical terms: 'I believe in the resurrection of the body'.

The Christian concept of time is also put forth as having played an important role in its preoccupation with the material world. For the East, it is argued, time is a placid, silent pool in which ripples come and go. For Christianity, it is an irreversible river, having origin, direction, and destination. From the historical reality of the Exodus to the anticipated return of Christ and the coming of His kingdom on earth, the assumption that time is a linear progression is constantly made. Christianity's Incarnation and Resurrection are said to reinforce this future oriented character of Western religious philosophy, and, in fact, the notions of progress and the work ethic are seen as being direct descendents of this fundamental notion of the progression of time. Even the life of God, for purposes of the Christian religion, is said to be considered in relative time, which, while termed 'everlasting time', is still outside the sphere of metaphysical eternity.

Contemporary Christianity, then, is portrayed in this critique as being highly dualistic. Everything is dichotomised into good or bad, right or wrong, this or that, subject or object, and individual self or God. God is generally assumed to be 'out there' and the world of the senses is what is considered to be real as opposed to the world of the spirit. One of the most significant results of this preoccupation with the material world and with the/

the separation of subject and object is that it is portrayed as having inspired tendencies toward religious authoritarianism and exclusiveness, and has produced cultures that have turned to aggression on the slightest pretext of religious zeal. Our own culture, for example, is advanced as having initiated the Crusades, the Holy Inquisition, the Puritan Revolution, the Thirty Years War, and as having subjugated and culturally destroyed India, Africa, China, and the native civilisations of North and South America, all under the banner of Christian righteousness. It is as if Christian man cannot bear to think of himself as finite, or to accept the conditions of finite life. He must continually be reshaping the world to his own ends, which he perceives as having been divinely revealed to him. Alan Watts has had the following to say of this peculiarity of the Christian religious tradition:

> 'Such an attitude is natural to people who are extremely self-conscious, who are keenly aware of their own separateness from God on the one hand, or from the natural universe on the other. The sense of the isolation and loneliness of the ego is one of deep insecurity, manifesting itself in a hunger to possess the infinite.' 36

The relevance this attitude has had in the Christian experience of the last century, is said to be that Christian man has used technology to systematically abolish the perceived confines of time and matter. The object, it is argued, has been to possess God, or at least give man a godlike power by mastering nature through the use of science and technology.

36. Alan Watts, The Supreme Identity (Random House, Inc., New York, 1972), p. 28.

The non-Christian religious tradition, particularly the Asian, is portrayed by the conventional ecological wisdom adherents as having rejected the mastery ascribed to the human intellect by the West. In fact, it is argued that Asians teach that it is the body, which is locked in time and space, that obstructs the view of the essential self. If liberation from this finite human condition is to be attained, the concept of the individual self must be transcended, and the reality of the unity of all things must take its place. Daisetz Suzuki has explained this Eastern concept thusly: If one is to embark on the path of enlightenment he must first 'destroy the intellect, in the sense of completely transcending its power, and so reach the foundation of all things. For in the world of analysis and discrimination the self is predominant, and so long as the self is not destroyed we cannot enter the world of non-distinction'.[37] Consequently, the Asian tradition is portrayed as having turned inward, beyond the reaches of systematic logic. One manifestation of Asia's preoccupation with this inward quest is seen by the elaborateness of its psychological vocabulary. Coomaraswamy, while curator of the Oriental Museum in Boston, claimed that for every psychological term in English there are four in Greek and forty in Sanskrit.[38] Even such believers in the Christian doctrine as Hendrick Kraemer, a leader of the Barthian school, have admitted that:

> 'The wisdom of the East possesses a greater/

37. Daisetz Suzuki, What is Zen? (McGraw-Hill Book Co., New York, 1971), p. 74.

38. Swami Turiyananda, 'Spiritual Talks', Vedanta for Moderin Man (New York, 1972), p. 84.

> greater psychological virtuosity in analysing man, in order to teach him to manage and master himself by spiritual and other kinds of training. As is well known, Eastern wisdom and spiritual experience meet here with the greatest discoveries in psychology and psychotherapy since Freud.' 39

One of the first things Christian apologists usually do to refute the arguments of the conventional ecological wisdom group, is to point out the incredible contextual differences between the age of the Old Testament and the world of today. They assert that an argument linking the first chapter of Genesis, whatever it contains, to the present crisis of the environment is to ignore the basic principles of cultural history. Genesis I is very old, the ecological crisis is very new, and a lot has happened in between. Even a devotee of Biblical literalism would have to admit that between the writings of Genesis I and the present day occurred many cataclysmic events, such as the rise of the Roman Empire, the founding of the Christian Church, the Crusades, the Renaissance, the Reformation, the American and French Revolutions, the Industrial Revolution, and two world wars. Surely, it is argued, those events, plus a good many others, worked upon the Christian tradition as profoundly as the Christian tradition worked upon them. The world in which we live is dramatically changed from the world of the ancient Hebrews. If our worldview contains axioms first formulated by them, it is concluded, surely we understand them differently, and apply them differently, if only by virtue of an immense separation in time and experience.

39. Hendrick Kraemer, as quoted by Huston Smith, 'Accents of the World's Religions', Comparative Religion, 1972, p. 4.

A second standard counter-argument launched by the defenders of the Christian doctrine, is that it must be kept in mind that Genesis contains the products of two quite different traditions within the Hebraic religion, the Yahwist and Priestly traditions.[40] John MacQuarrie, in an article in reply to White's own, remarked that while the older J tradition certainly does accord man the central position in the creation, the later P places more emphasis on man the creature than man the overlord.[41] John Baker is in agreement with this interpretation, and points out that 'the major difference ... is that in Genesis I the theme of a common origin for men and animals is suppressed altogether ... whereas in Genesis II both men and animals were fashioned by God from the soil ...'[42] It is argued by the Christian apologists that the Priestly emphasis crops up again and again throughout the Old Testament, such as in the Rainbow Covenant God makes with Noah and all the other creatures, and in the Psalms of praise. As MacQuarrie states, Prophetic Judaism, like the J tradition, 'stresses history against nature and upholds the transcendence and otherness of God. Priestly religion smacks rather of the earthly, the imminent, even the pagan'.[43]

40. See Gerhard von Rad, Old Testament Theology, Vol. I (Harper and Row, Ltd., London, 1962), pp. 136-161.

41. John MacQuarrie, 'Creation and Environment', in Spring and Spring, op.cit., pp. 32-47.

42. John Austin Baker, 'Biblical Attitudes to Nature', in Hugh Montefiore, ed., Man and Nature (Collins, Sons and Co. Ltd., London, 1975), p. 89.

43. MacQuarrie, op.cit., p. 37.

James Barr, in a reply to White's initial article, goes to great length to examine what man's dominion means in the face of human creatureliness and divine sovereignty. He returns to the original Hebrew words of 'dominion' and 'subdue' and finds that there are both strong and less strong meanings implied. When the less strong meanings are emphasised, he claims, dominion can be interpreted as a parallel to benevolent kingly rule, like the dominion of Soloman - 'expressly a peaceful dominion'. Subdue, which he points out as 'not used of the animals but only of the earth', is seen as concerning no more 'than the basic needs of settlement ...'[44] Basically, then, what is intended, according to Barr, is only human 'tilling', and he concludes that 'we can thus expect that the exegetics will in the future tend to reduce their emphasis on the 'strength' of the terminology for man's dominion over nature in Genesis'.[45]

Barr cites Westermann's interpretation of dominion to mean a sort of royal supervision. '... there is no idea of exploitations' he contends, 'and man would lose his "royal" position in the realm of living things if the animals were to him an object of use or of prey.'[46] Therefore, Barr deduces:

> '... the whole framework of Genesis I is intended to suggest that man is man when he is in his place within nature. His dominion over nature is given little definition; but, in general, its content is less exploitation and more leadership, a sort of primary liturgical place. That man's dominion or eminance should from now on increasingly be applied to the task of conserving and caring for the natural resources of God's/

44. James Barr, 'Man and Nature: The Ecological Controversy and the Old Testament', in Spring and Spring, op.cit., p. 63.

45. Ibid., p. 64.

46. Ibid., p. 65.

> God's world ... is entirely consonant with the tendency of the Old Testament.' 47

As to the argument that the imago dei gives man license to ravage nature by virtue of his resemblance to God, the question at once arises: What sort of God must be postulated in order for the argument to have logical consistency? Claus Westermann's interpretation of the primary meaning of the imago dei presents a clear alternative:

> 'Man in his entirety, corporeally as well as spiritually and intellectually, is to be designated as a creature in God's image. We cannot attempt to discover what in man is like God's image. Actually, the primary concern of the statement is not about man, but about the creative act of God. This makes it clear that man is thus set apart from everything else that is created; but it is to be understood only in the total context of the creation story. One cannot make out of this an assertion concerning the nature of man ... the statement really means that God has made man to communicate God's word. This, then, shows us the goal of creation. God made man after his image so that the stream of life might flow in the encounter between God and man, through which, even though we cannot fully understand it, God works toward the goal of all creation. This in no sense means a "likeness" to God's image; which man could count as his possession and by virtue of which he, apart from the Creator, could think of himself as the Crown of Creation. This description of man means, rather, that man can attain his humanity only in the presence of God. Man separated from God has not only lost God, but also the purpose of his humanity.' 48

Furthermore, Christian apologists argue that the assumption made in the conventional ecological wisdom analysis, that the image of God borne by man in the Christian doctrine is the mark of man's divinity/

47. Ibid., p. 74.

48. Claus Westermann, The Genesis Accounts of Creation (Fortress Press, Philadelphia, 1964), p. 20.

divinity, completely ignores the Christian understanding of the Fall and its manifold implications. Indeed, as James Barr has asserted, neither White, Toynbee, nor McHarg seem to have remembered sin. It is precisely what H. Richard Niebuhr calls the 'inversion of faith',[49] whereby man places himself in the centre of cosmic reality and therefore compounds human self-idolatry with a turning away from, if not an actual displacement of, God, that defines Christian sin.

The second recurring theme in the conventional ecological wisdom's indictment of Christianity is the comparative one - the Christian West vs. pre and non-Christian 'paganism'. However, say the Christian apologists, a number of serious problems with this argument have recently come to light regarding environmental issues. One they cite, is the ample archaeological and paleoecological evidence that men somehow managed to make major changes in the earthly landscape, not all of them beneficial to the ecology, long before the advent of monotheistic religion. This was true in China as well as in Mesopotamia, they argue, despite the fact that China never became monotheistic in its indigenous religious systems.[50] Of the presumed pagan awe before nature, Barr writes: 'Whatever seems to be theoretically likely or probable, hard evidence does not seem to have been produced to show what sort of connection there was between natural elements in ancient mythologies on the one hand, and the way in which ancient peoples in practice perceived nature'.[51] Indeed/

49. H. Richard Niebuhr, The Meaning of Revelation (MacMillan Co., New York, 1941), p. 31.

50. See Yi-Fu Tuan, 'Discrepancies between environmental attitude and behaviour: Examples from Europe and China', in Spring and Spring, op.cit., pp. 91-113.

51. Barr, op.cit., p. 72.

Indeed, while evidence is lacking concerning the manner in which pagans perceived nature, there is more than a little evidence that they were not so reverential in their treatment of it as to develop massive agricultural systems, for example, merely in nature's favour. Ancient irrigation systems, point out the defenders of Christianity, were instituted for reasons of human need, quite apart from their effect on non-human living systems. Lewis Moncrief has recalled that it was Lynn White, Jr., himself who pointed out that: 'Human intervention in the periodic flooding of the Nile River Basin and the fire-drive method of hunting by pre-historic man have both probably wrought significant "unnatural" changes in man's environment. The defence of Judeo-Christian influence in these cases is obvious.'[52]

John Passmore has gone one step further than this. His contention is that if there is a Christian teaching of man's mastery over nature, it is not of Hebrew origin at all, but Greek. Passmore cites evidence for his claim from Aristotle, Seneca and the Stoics, Origon, St. Paul, and others, all to the effect that nature was very much in the category of 'other' and 'lesser' than man. And the Greek pantheon, he points out, was far from consisting of tree Gods and stream Gods.[53]

In comparing the Christian attitude toward the natural realm with that of the Eastern religions, Christian apologists have published a great deal of evidence which indicates toleration of non-ecological practices in just about every major religious tradition.

52. Lewis W. Moncrief, 'The Cultural Basis for our Environmental Crisis', in Spring and Spring, op.cit., p. 79.

53. John Passmore, Man's Responsibility for Nature (Duckworth and Co. Ltd., London, 1974), pp. 13-17.

Not only in the case of Christianity, they argue, but in other cases too are found elements of rejection of and indifference to the world. For example, in a study of Hindu and Buddhist thought, Ninian Smart claims that there is a sharp distinction made by these two great religions between 'the soul as an eternal entity and the psycho-physical organism plus nature'. It is this distinction, Smart continues, that 'is in part the background of the other-worldliness of Indian asceticism'.[54] In a similar vein, it is often pointed out, on Christianity's behalf, that an Eastern religious tradition certainly did not prevent Japan from rapidly developing one of the most ecologically unsound technologies in the world. Furthermore, as pointed out by Phyllis Trible, the idea of 'harmony with nature' in the Zen Buddhist tradition not only includes but depends on 'the manipulation of nature'. Her argument runs that 'the Buddhist creates rock gardens, flower arrangements, miniature trees, and other artistic expressions of faith. He stands over nature, controls it and orders it even though he may finally minimise himself in relation to it'.[55] She thus concludes that 'it is misleading simply to contrast the two phrases "dominion over the earth" and "harmony with nature" as describing opposing views in Western and Eastern thought'.[56]

Somewhere between the arguments presented by the Christian apologists and those of the conventional ecological wisdom group, is/

54. Ninian Smart, as quoted by Don Cupitt, 'Some evidence from other Religions', in Montefiore, ed., op.cit., pp. 164-165.

55. Phyllis Trible, 'Ancient Priests and Modern Polluters', Foundations, no. 2, April 1974, p. 132.

56. Ibid.

is a third position. This position finds neither the argument from Biblical Scripture, nor the comparative religious case, as sufficient to account for the origins or the persistence of global environmental irresponsibility. While this posture does find obvious elements of complicity between Christian theology and the ill-use of nature, it contends that these elements of complicity are not essentially different from those which are present in the wider cultural atmosphere. As H. Paul Santmire asked, 'Why has the modern West as a matter of course read the Bible through the eyes of Adam Smith rather than St. Francis?'[57]

It is quite evident that the idolatry of the human at the expense of the non-human has increasingly characterised the self-understanding of the West since, roughly, the Industrial Revolution. Christian theology is guilty of this tendency, insofar as it appears to have given religious legitimation to a cultural tendency that is by no means exclusively religious. Santmire has pointed out that it is unlikely that the appearance of an explicitly man-centred Christianity and the arrival of the Industrial Revolution at roughly the same time was merely accidental.[58] Late nineteenth century theology, particularly liberal Protestantism, was clearly exuberant in its affirmation of human possibilities - for more political liberty, for the improvement of the material condition of men, for better and more effective education, and for advances in the sciences and the humanities. Unfortunately, this exuberance led to a religious interpretation that became/

57. H. Paul Santmire, op.cit., p. 133.

58. Ibid., p. 147.

became homocentric in two major respects. In this era of vast potential, evidence that human history was the locus of beneficial progress and that there existed a seemingly inexhaustible potential for more, in the material sense, abounded. This was a time when man was wholly consumed with his own affairs. Either he was consumed with the notion of material progress that required the utilisation and consumption of natural resources - for the development of industry, imperialistic expansion, and the conquest of the world's frontiers - or with the redress of social ills. Both entailed the subordination, if not the total disregard, of concern for the well-being of the non-human reality. It must be emphasised that this theological homocentricity does not and did not exist in a cultural void. Certainly, neither a biocentric nor a geocentric worldview characterised the period 1850-1950, any more than it characterises the present, even with all our attendant recognition and acknowledgement of the environmental crisis. Theological homocentrism, therefore, appears to be only a part of the larger Western industrial culture.

CHAPTER III

CHURCH RESPONSES TO NUCLEAR ENERGY

HISTORICAL SURVEY

On May 11, 1979, the Governing Board for the National Council of Churches (NCC) voted overwhelmingly in favour of a national energy policy for the United States 'which does not need to utilise nuclear fission'.[1] Two and a half months later, on July 24, 1979, the World Council of Churches (WCC) made an official recommendation to the nations of the world to put into effect a five-year moratorium on the construction of any new nuclear plants. At this same time, the WCC also called on national governments to avoid reprocessing spent nuclear fuel or constructing plutonium-fuelled reactors, and to use existing nuclear plants 'only to the extent, for the purpose, and for the time there is no better alternative'.[2] For both the NCC and the WCC, these anti-nuclear energy positions reflected dramatic policy shifts from previously expressed support for the peaceful use of nuclear power. Until the mid-1970s, in fact, no Christian church group had offered any real challenge to the social costs and risks associated with nuclear energy. The churches, until that time, had merely accepted the nuclear industry's assurances regarding the safety of the nuclear programme, while giving support to the fission process which 'seemed to offer a way of redeeming a technology which had previously been used only to make weapons'.[3]

1. James Wall, 'NCC says No to Nuclear Power', Christian Century, No. 19, May 23, 1979, p. 579.

2. John Bluck, 'The Great Debate', One World, No. 49, September 1979, p. 16.

3. Paul Abrecht, 'The Churches and the Nuclear Energy Debate', Ecumenical Review, July 1978, p. 220.

Uncritical acceptance of the 'atoms for peace' argument by the churches had already become apparent by the early 1950s, when C.A. Coulson wrote that Christian believers in God's will, 'are committed to a fair and reasonable distribution of atomic energy'.[4] Throughout the 1950s and 1960s, Christian churches gave at least tacit, and sometimes overt, endorsement of the proposition that the development of nuclear energy could solve many of the world's problems. Atomic energy, it was believed, could be instrumental in irrigating central Australia and arid parts of the United States, could favourably modify the climate of Siberia, and could even be used to cure some diseases.[5] In 1960, the NCC adopted a statement that urged private industry to launch an all-out development of nuclear fission as an energy source. By the mid-1960s, a simplistic division of labour had apparently become established regarding the ethical questions of nuclear energy, with nuclear technologists concentrating on the techniques, and priests and humanists concentrating on the ways to give those techniques meaning and purpose.

According to Paul Abrecht, four developments in the early years of the 1970s undermined the prevailing church complacency concerning atomic energy. These developments included increased public awareness of reactor safety deficiencies, of the link between nuclear power and nuclear weapons, of the environmental hazards of radioactive waste, and of the irreversibility of a move towards uncertainty/

4. C.A. Coulson, 'Nuclear Knowledge and Christian Responsibility', London Quarterly and Holburn Review, January 1954, p. 41.

5. Ibid., pp. 45-46.

uncertainty and anxiety that comes with a commitment to nuclear technology.[6] With the WCC leading the way, Christian churches carefully entered into the nuclear debate in the mid-1970s. This chapter will briefly trace the involvement of the WCC, the NCC, and the British Council of Churches (BCC) in the recent acceleration of the nuclear energy debate. Sections will also be included on the contributions made to the debate by the French Protestant Federation (FPF), the Evangelical Church in Germany (EKD), and independent British church groups.

The World Council of Churches (WCC)

In 1969, the WCC initiated a five-year study designed to evaluate, from an ecumenical perspective, the social and human implications of the modern scientific and technological revolution. This study, undertaken by the Sub-Unit on Church and Society, sought 'a new understanding of the limits, dilemmas, and uncertainties of a scientifically and technologically shaped society'.[7] The study concluded with a conference on 'Science and Technology for Human Development' held in Bucharest, Romania from June 24 - July 2, 1974, which was attended by one hundred and forty scientists, technologists, and theologians. The conference made specific reference to the energy crisis, and agreed that the WCC, through the on-going work of the Church and Society Sub-Unit, should advance the Concept of a 'just/

6. Paul Abrecht, op.cit., pp. 221-222.

7. WCC Committee of Church and Society, 'A New Ecumenical Vision of the Future', Anticipation, No. 19, November 1974, p. 5.

'just and sustainable society', where each individual could be assured of the 'availability of energy at the lowest possible price'.[8] However, how this concept was to be established in a world of rapidly increasing energy costs and with nations at various stages of development, was a matter of debate. As far as the development of nuclear energy was concerned, the conference was fairly polarised, with some participants advancing it as a significant future contribution to energy economics, and others perceiving it as non-sustainable for the world's energy supply. Left with this deadlock, the conference proposed that the WCC continue to study the major moral, economic, social, and scientific implications of the extension of atomic energy plants throughout the world. This recommendation was eventually approved by the Central Committee of the WCC, and plans were advanced to hold an ecumenical hearing on nuclear energy the following year. As described by John Francis, the basic notion behind the hearing was to provide 'a "third room", where the pro- and anti-nuclear factions could listen to one another's arguments and, in the event of a successful exchange of views, the WCC might attempt to moderate in the debate'.[9]

The hearing on nuclear energy was set for June 1975, at Sigtuna, Sweden, and was to bring together nuclear scientists, engineers, theologians, politicians, and community leaders to discuss the 'risks and potentialities of the further expansion of nuclear power programmes'. To help prepare a climate of confrontation, the WCC devoted its May 1975 issue of <u>Anticipation</u> exclusively to nuclear/

8. WCC, 'Search for a Just and Sustainable Society', <u>Study Encounter</u>, No. 4, 1974, p. 3.

9. John Francis, 'Energy Policy: The Nuclear Hang-Up', (unpublished), p. 11.

nuclear energy. This edition of Anticipation presented a balanced account of the nuclear debate, and included articles ranging from the wholly positive to the wholly negative aspects of expanded nuclear energy programmes. The hearing was eventually convened on June 24th, and involved thirty-seven participants, who reflected a wide range of views on energy problems in general, and on nuclear energy in particular. In addition to background papers circulated in advance, a number of the participants were invited to submit papers on specific aspects of the nuclear energy issue, which were then discussed in plenary and small group sessions. The hearing was divided into three working groups, with the reports from these groups, plus the advanced papers, plus the specific papers presented in plenary, being integrated into a single report of the hearing. This report was then published in the October 1975 edition of Anticipation.

Basically, the Sigtuna's appraisal of nuclear energy concentrated on three major topics - risk assessment and the criteria for public acceptability, radiological and operational hazards, and the relationship between nuclear power programmes and nuclear weapons. The key factor discussed in the assessment of nuclear risks was that of the societal context. While it was deemed reasonable to suppose that the discipline required in operating a nuclear fuel cycle with minimum risk was within the capabilities of an orderly society, it was felt that this was not the case in those societies which have a demonstrated potential for political, economic, or social disruption. The attendent issue concerning public acceptability of a comprehensive assessment of nuclear risk, was presented as an absolute requirement in the future utilisation of nuclear power. Here, it was felt, churches could provide an ethical setting for a continued/

continued dialogue between both sides of the nuclear argument, as well as interpret, assimilate, and disseminate the complexities of the debate to the general public.

The report dealt with the various radiological hazards, which occur throughout the nuclear fuel cycle, in considerable detail. While the maximum permissible radiation dosage allowed by the International Committee on Radiation Protection was generally accepted as adequately safe, the report did stress the need for further research into the possible long-term cumulative effects of radiation exposure. Likewise, on the subject of operational hazards, the report appeared to accept the present trend of replacing conventional fossil fuels, as the source of electrical energy in large urban centres, by nuclear fuels. The only positive note sounded by the hearing was that there would probably be no general availability of fast breeder reactors before 1990. Given the hazards involved in this level of nuclear technology, it was voiced by the hearing that hopefully the fifteen year interval would yield 'breakthroughs as far as non-nuclear energy sources are concerned'.[10]

The final topic stressed at Sigtuna was the 'tightness of the coupling' between nuclear power generation and the production of nuclear weapons. As certain as the hearing appeared to be as to the ineffectiveness of the Non-Proliferation Treaty in the prevention of the spread of nuclear arms, it appeared quite undecided as to whether the stoppage of nuclear energy programmes would have any effect on the proliferation hazard or not. 'It is part of the tragedy of our/

10. Ibid., p. 14.

our times', the report concluded, 'that we see no simple way out of the present dilemma of our world: faced with the potentiality of nuclear energy and the fear of nuclear warfare'.[11] In this respect, the potential of the churches to influentially lobby their respective governments for the strengthening of international weapons control was emphasised.

While the Sigtuna Hearing admittedly left many participants in a state of 'perplexity' over the nuclear energy issue, it made an important contribution to the nuclear debate by proving that dialogue between people with widely differing backgrounds, coming from many different countries, is possible. The hearing also contributed to the debate by shedding ecumenical light on the various complexities of nuclear technology, and, as has been subsequently demonstrated, served as a stimulus for continued theological probes into the dilemmas of the energy supply problem from many church groups. For example, some church groups, like the NCC of the United States, came away from Sigtuna convinced of their responsibility to challenge the development of nuclear power, especially in regard to the use of plutonium fuel and breeder technology. Thus, although the hearing concluded by neither rejecting nor endorsing the use of nuclear energy, it was a strong start to ecumenical encounter with the manifold intricacies of the nuclear issue.

The Sigtuna report was generally well-received by both those opposed to as well as those in favour of nuclear energy.[12] It was also/

11. WCC Committee of Church and Society, 'Ecumenical Hearing on Nuclear Energy: A Report to the Churches', Anticipation, No. 21, October 1975, p. 14.

12. See 'Responses to the Sigtuna Report', John Francis and Paul Abrecht, eds., Facing Up to Nuclear Power (St. Andrew Press, Edinburgh, 1976), pp. 221-230.

also favourably reviewed by the Nairobi Assembly of the WCC in December 1975. In fact, primarily based on the work done at Sigtuna, the Nairobi Assembly synthesised the various dilemmas of nuclear power into three ethical considerations - 'The inevitable coupling of nuclear energy for electricity generation and the production of nuclear weapons ...', 'The hazards involved in the storage of nuclear waste for long periods ...', and, 'The problems of theft and sabotage.'[13] The assembly emphasised that ecumenical discussion of these issues needs to be continued, and called upon churches and individual Christians to voice their reactions to the Sigtuna findings. The assembly also noted the importance of future research into the development of alternative systems of energy production, and recommended that all concerned Christians actively seek to 'promote sufficient funding and moral support for research and development of renewable sources of energy, e.g. solar and wave energy'.[14] It was concluded by the assembly that the Sub-Unit on Church and Society should continue its investigations into the nuclear energy debate, particularly as it relates to the crises in population control, food and energy resources, and the entire environmental problem. The continuity of this work was seen as being especially essential if the churches were to 'mobilise groups at a local congregational level'.[15]

The involvement of the WCC in the nuclear debate was taken one step further in May 1976, with the publication of the Church and/

13. WCC, 'Social Responsibility in a Technical Age', Anticipation, No. 22, May 1976, p. 8.

14. Ibid., p. 10.

15. Ibid., p. 11.

and Society's 'Energy for a Just and Sustainable Society'. Not only did this report bring the nuclear argument up to date since the Sigtuna Hearing, but it also weighed the pros and cons of the recommendation for a nuclear moratorium. While admitting that a moratorium is merely a delay tactic - only deferring the decision to proceed with nuclear production or to stop it - the report cited two major reasons for supporting such an event. The first was that a moratorium would at least slow the developmental process of nuclear energy, and would give the public time for comprehensive discussions on the issue. The second reason was that a moratorium would give the scientific community opportunity for special research on the various technical dilemmas, where more information is needed for enlightened decisions. However, the report also advanced two convincing reasons for the resistance of a moratorium call - the possible reduction of available energy to poorer countries, and the possible creation of a future energy crisis - and was left to conclude that a moratorium is not '... an easy way to avoid a decision. It is itself a decision with serious social consequences.'[16] Nevertheless, even though non-commital, the report's discussion of the moratorium issue did serve an important function by giving initial ecumenical attention to the potential effects of such a possibility.

In accordance with the recommendations made at Nairobi regarding further worldwide ecumenical involvement in the issues posed by the use of nuclear power, the Central Committee of the WCC, at a meeting in Geneva, August 10-18, 1976, authorised the Church and Society/

16. Working Group on Church and Society, 'Energy for a Just and Sustainable Society', Study Encounter, No. 3, 1976, p. 29.

Society Sub-Unit to make a presentation to the next international conference of the International Atomic Energy Agency (IAEA). This conference was to be held in Salzburg in May 1977, and the WCC submission was to be on the 'Public Acceptance of Nuclear Power'. It was felt by the Central Committee that such WCC involvement in the overall debate was necessitated by the apparent widespread agreement among the Christian churches that much more information was needed by the public on the implications and problems of the continued expansion of nuclear energy. It was also felt by the committee that there was a growing awareness in the churches that the ethical and religious implications of nuclear energy required urgent attention at the international level.

In preparation for the Salzburg Conference, the WCC published a policy statement regarding nuclear energy in August 1976. While this statement acknowledged the perceived necessity of retaining nuclear power as a world energy source, it also called for an intensified global search for viable alternative forms of energy. In addition, the policy statement requested direct assurance from the IAEA that new initiatives would be taken to both help resolve the present anxieties surrounding nuclear power technology, and to place the acknowledged risks of an expanding nuclear power industry in a more realistic long-term perspective.

The WCC delegation to the Salzburg Conference was led by Paul Abrecht, with John Francis presenting the WCC submission. Basically, the presentation given by Francis was taken from the previously stated WCC evaluations of the nuclear power issue, and reflected the by-this-time traditional, moderate WCC position. In his submission, Francis set out five considerations around which the WCC perceived an/

an ecumenical consensus to be developing. These five considerations were: that nuclear power cannot nor will not be abandoned as a world energy source; that the maturity of nuclear energy technology is not yet sufficient to justify large-scale industrial application; that the right of access to nuclear energy by all nations must be recognised; that all nations share the responsibility of nuclear access and security; and, that the widest possible public discussion of the complexities of, and options to, nuclear technology is essential. Francis examined each of these points in detail in the first section of his presentation, and dealt with the need for an ethical and religious perspective to the debate in his final part. This last section continued the cautious approach of the WCC, with Francis emphasising that although 'we cannot live as though nuclear energy had not been discovered ... the wise use of nuclear technology depends paradoxically on a new understanding of human limits'.[17] This non-commital policy was subsequently echoed by Paul Abrecht in an article summarising the Salzburg Conference. In this article, Abrecht defended the WCC refusal to take neither a pro- nor con-nuclear stance by rhetorically implying that nuclear technology is much like other previous technological achievements - fire, gunpowder, steam engine, automobile, airplane - and must be judged in terms of its relative advantages and disadvantages.[18]

The role of the WCC at Salzburg was to attempt to place the dilemmas of nuclear power into a social and ethical context. At that/

17. John Francis, 'Public Acceptance of Nuclear Power: Some Ethical Issues', WCC Exchange, No. 2, May 1977, p. 13.

18. Paul Abrecht, 'Churches' Voice Invited in the Nuclear Debate', WCC Focus, May 1977, p. 21.

that time, the WCC apparently did not feel confident enough to produce a 'yes' or 'no' response to the continued development of nuclear energy. As John Francis made clear:

> 'Religious traditions offer no ready made answer to the right use of nuclear technology ... A critical attitude towards technological reason must not lead to social confusion, to delight in the irrational, to the veneration of the simplistic and utopian solutions to human problems ... The churches and religious leaders are not in a position of moral superiority, but share the uncertainty which afflicts our contemporary culture.' 19

Consequently, the rather prudent WCC position first taken on the nuclear energy issue at Sigtuna - 'We would not feel justified in either entirely rejecting nor in whole-heartedly recommending large-scale use of nuclear energy'[20] - was reaffirmed at Salsburg. Abrecht referred to this position as a form of 'Christian Realism', and it was in basic agreement with the broader 'hard-soft' or mixed energy strategy (see Chapter One).

The WCC approach to the nuclear debate was shifted somewhat into the anti-nuclear camp at the Church and Society Sub-Unit's Consultation held at Bossey in May 1978. This consultation was attended by some sixty persons representing a wide variety of professions, and its discussions tended to broaden the ecumenical scope regarding the nuclear issue. While many controversial nuclear complexities were heatedly debated and ultimately left unanswered, the consultation did manage to reach some agreements as to the general ethical questions/

19. Ibid., p. 12.

20. Paul Abrecht and David Rose, 'The Churches and the Salzburg Debate on "Nuclear Power and its Fuel Cycle" ', Anticipation, No. 24, November 1977, p. 7.

questions involved, and was able to produce a detailed statement dealing with many of the major dilemmas posed by nuclear technology. Some of the issues particularly emphasised by the consultation were the encouraging prospects of non-nuclear energy sources, the manifold social costs and risks of nuclear energy, the special hazards inherent in breeder technology, and the distressing prospects for the eventual proliferation of nuclear weapons given the continued expansion of nuclear energy. The Bossey Consultation elevated the renewable, alternative energy sources of solar, wind, and biomass to the status of 'fully-fledged' energy options, and maintained that all energy alternatives must be kept open. The consultation also stressed the deeper societal debate within which the nuclear controversy is set. It defined this deeper debate as being ultimately about 'more technology or less, about centralised (technology) versus decentralised ....',[21] and admitted the existence of an ecumenical quandary on the subject. While the consultation did follow the established WCC party line by concluding that 'no grounds exist for rejecting nuclear power categorically. On the other hand, it cannot be accepted categorically either',[22] it broke new ground toward an anti-nculear stance by declaring that nuclear power 'is a conditional good, subject to reasoned acceptance under some circumstances and subject to reasoned rejection in others. Even where accepted there may be a point when we may have to say, "Thus far and no further".'[23]

21. Working Group on Church and Society, 'A Statement by the Working Committee of Church and Society', Anticipation, No. 26, June 1979, p. 51.

22. Ibid.

23. Ibid.

The criteria delineated at Bossey for either the ultimate acceptance or rejection of nuclear power included the need for energy, the availability of alternative sources, the likelihood of increasing or decreasing the danger of proliferation, and whether nuclear power in any particular case contributes to a more just, participatory, and sustainable society. The notions of societal justice and sustainability were later defined by the consultation to include correcting the maldistribution of the products of the earth, bridging the gap between rich and poor countries, and sustaining the earth so that a sufficient quality of material and cultural life for humanity may itself be sustained indefinitely. This global and environmental perspective was perceived as essential, given humanity's dependence upon the earth. The interrelationship of justice and ecology, as presented by the consultation, was perceived as residing in the beliefs that: 'a sustainable society which is unjust can hardly be worth sustaining', while 'a just society that is unsustainable is self defeating'.[24]

While the overall conclusion of the consultation at Bossey was that nuclear power was a conditional option for future world energy needs, a full third of the participants filed a dissenting opinion which called for an immediate moratorium on the use of plutonium reactors and spent fuel reprocessing plants. Six additional participants submitted a post-consultation position paper which criticised a perceived predisposition on the majority of the consultation's part toward a pro-nuclear energy stance. This paper claimed that 'certain crucial theological aspects of the argument/

24. As quoted by David Gosling, 'Energy for the Future' (British Council of Churches, London,1979), p. 2.

argument surrounding nuclear energy, of considerable importance to the churches, were prevented from surfacing',[25] and argued that the earth's ecological constraints do not justify the continued use of nuclear energy.[26]

The Central Committee of the WCC reviewed the results of the Bossey Consultation at a meeting held in Jamaica in January 1979. Here, the committee emphasised the importance of viewing benefits of nuclear energy in the light of risks involved, and laid great stress on the need for energy conservation and more rational energy consumption. The committee also underscored the wider ecological context of the nuclear energy debate. Although the committee did acknowledge the validity of some of the points raised by the minority opinion at Bossey, it backed away from taking either a pro- or con- position on the nuclear energy issue, claiming that 'nuclear power can be neither rejected nor accepted categorically'.[27]

The persistant WCC nuclear energy position, which can only be described as cautious and non-committal, was finally abandoned at the Conference on Faith, Science and the Future held in July 1979. As previously mentioned, this conference not only endorsed a nuclear moratorium, but also called for the abandonment of plutonium reactors and spent fuel reprocessing plants, and for the very limited use of currently operating nuclear reactors. The conference felt that the/

25. Gerd Anne Aarset, et.al., 'Reaction to the Report from a Group of Participants', Anticipation, No. 26, June 1979, pp. 45-50.

26. Ibid., p. 50.

27. WCC, 'Energy for the Future', Reports from the World Conference on Faith, Science and the Future (WCC, Geneva, 1979), p. 1.

the benefits to be derived from a global commitment to these recommendations would include 'breathing space' for technological improvements, alternative energy source investment, and the accumulation of adequate capital for such eventualities as nuclear plant decommissionings and decontaminations. The conference also felt that the related issue of nuclear warfare, with its attendant questions of disarmament, proliferation, and nuclear safeguards, also necessitated an immediate moratorium. Although the effects of such a moratorium on the energy requirements of the Third World were heatedly discussed, it was felt by the majority of participants that nuclear power was rapidly becoming cost-prohibitive for most developing countries. Furthermore, it was the consensus of the conference that, unfortunately, little could be done either way to solve what was considered to be the ultimate political dilemma of Third World nations: '... to be dominated by the military power of the nuclear states or to be dependent on them for developing nuclear capability'.[28] Nevertheless, the conference expressed the opinion that a possible moratorium - induced global move toward decentralised, less capital-intensive energy technologies would ultimately benefit the developing world. The hope was also voiced by the conference that if governments were to follow the nuclear recommendations set forth, and adopt feasible energy strategies which would not reduce present standards of living, it would soon become apparent that the nuclear option could be avoided with, at worst, only minimal costs. While there was a minority viewpoint voiced in dissent of the moratorium call, the conference plenary approved it by a substantial majority - 129 votes for, 45 against, and 21 abstentions.

28. Ibid., p. 14.

The conference's nuclear recommendations formed part of a larger energy strategy promulgated at the same time. This more comprehensive strategy recommended the utilisation of a mix of energy technologies depending on the availability of regional, natural, financial, and industrial resources; and appeared to be in basic agreement with the 'hard-soft' energy path as described in Chapter One. While the conference stood fast in its belief that all energy options, including nuclear power, should be kept available for possible use in the long term prospect, it was equally as certain that 'for the short and medium terms ... a major shift towards the effective implementation of the huge potentiality as yet untapped of the soft option'[29] was called for.

The conference's concluding remarks to its energy deliberations considered various socio-ethical difficulties involved in weighing the moral criteria which relate to the complexities of the energy debate. While it was readily acknowledged that 'churches do not ... have a monopoly of insight into such matters',[30] the conference defended church involvement and perceived a heavy church responsibility to 'play a role in the decision-making process, insisting on the seriousness and magnitude of the issues, the urgency of facing them squarely, and offering, where possible, to provide a forum in which the ethical factors can be elucidated and debated'.[31]

29. Ibid., p. 10.

30. Ibid., p. 15

31. Ibid.

The National Council of Churches (NCC)

The official entry of the NCC into the nuclear energy debate came in 1974, when the growing use of nuclear energy, plus plans for the development of plutonium reactors, prompted the NCC's Division of Church and Society to initiate a study group on the ethical issues of the nuclear energy debate. The only previously stated official position of the organisation had been a statement adopted in 1960, which supported the peaceful uses of nuclear energy, and urged private industry to launch an 'all-out development of nuclear fission as an energy source'.[32] In a dramatic shift from this acceptance of nuclear energy, the study group formed in 1974, by the Church and Society Division, was given the specific task to investigate the implications of using plutonium as fuel in the nuclear cycle. The group that was eventually formed came to be known as the Committee of Inquiry on the Plutonium Economy, and was co-chaired by Margaret Mead and Rene Dubos. The results reached by this committee were presented to the Division of Church and Society in the Fall of 1975, and became the basis of a policy recommendation given by the Church and Society Division to the NCC Governing Board in March 1976.

The basic position argued in the Mead-Dubos Report was that plutonium is an unacceptable energy alternative - that even though the technology exists to utilise plutonium-fueled energy, it is ultimately 'morally indefensible'.[33] The report charged that the/

32. James Wall, 'NCC says No to Nuclear Power', Christian Century, No. 19, May 23, 1979, p. 579.

33. James Wall, 'The Plutonium Threat', Christian Century, No. 34, October 22, 1975, p. 915.

the price of developing plutonium technologies could possibly be a police state, or, worse yet, the destruction of the world by one disturbed individual, one terrorist group, or one nation bent on nuclear blackmail. The report also devoted lengthy sections to the issues of plutonium toxicity and the ultimate disposal of wastes. In its conclusion, the committee asked the NCC and its member churches to lobby for the various alternatives to plutonium - which included 'energy conservation, solar energy, advanced fossil fuel and organic conversion techniques, geothermal energy, and eventually perhaps fusion energy'[34] - all of which were regarded as socially and environmentally preferable to the use of plutonium as an energy source.

With the experiences of the Sigtuna Hearing providing an admittedly great degree of initiative, the Church and Society Division of the NCC favourably received the findings of the Mead-Dubos Committee in late 1975, and proceeded to draft its policy recommendation to the NCC Governing Board. The initial reading of the division's subsequent nuclear policy statement occurred in October 1975, and, among other things, it recommended an immediate moratorium on 'decisions to pursue plutonium reactors as a major energy source'.[35] The statement also recommended continued study on the ethical dimensions of the energy issues, and called for ecumenically - supported public discussions of the risks involved in advanced nuclear technology. As had been expressed in the report of the Sigtuna Hearing, the Church and Society's policy statement voiced the hope that the/

34. Ibid.

35. 'The NCC and Nuclear Power', Christianity and Crisis, May 10, 1976, p. 105.

the relatively neutral position of the church could be used to provide a suitable forum for continued dialogue between both sides of the nuclear debate.

In January 1976, the Division of Church and Society sponsored a consultation on the recommendations contained in its policy statement. The participants attending the consultation included advocates of the proposed plutonium moratorium, three scientists chosen by an industrial group - the Atomic Industrial Forum - and three Christian ethicists. The stated purpose of the consultation, according to the programme, was 'to provide the NCC Governing Board with an opportunity to hear and to participate in a discussion of the plutonium economy, in company with acknowledged experts from several disciplines and points of view'.[36] It was obviously hoped by the Church and Society Division that the consultation would help create a climate of confrontation within ecumenical circles, which would set the tone for the next NCC Governing Board meeting, scheduled for the following March. The Church and Society's stake in this forthcoming meeting of the Governing Board was obvious, as its policy statement had already been placed high on the agenda for discussion.

If confrontation was one of the purposes of the January consultation, it quickly exceeded its expectations, with both proponents and opponents of the Church and Society's policy statement lamenting the other's biases and unenlightened positions.[37] The/

36. Sheila Collins, 'Alice in Wonderland (at Riverside Church)', Christianity and Crisis, March 15, 1976, p. 19.

37. For a comprehensive account of the consultation's proceedings see: 'The NCC and Nuclear Power', op.cit., pp. 105-111; and Sheila Collins, op.cit., pp. 49-51.

The proponents of the statement, led by Hannes Alfven, argued against the further expansion of nuclear power in general, and the development of plutonium technologies in particular, on four major grounds. These grounds were: that the production of large quantities of unstable radioactive materials is environmentally unsound; that with the coupling of nuclear weapons and nuclear energy one is forced to either accept both or neither; that nuclear energy is more expensive than alternative sources; and, that a non-nuclear energy mix involving reduction of energy use, conservation, solar heating, and limited use of coal and oil is a much more attractive method of solving the world's energy problems. The opponents of the policy recommendations counter-argued that not only is nuclear power environmentally safe when compared with other energy production methods, but that it is also a proven process of energy generation, unlike the hypothetical nature of many of the alternatives put forth. The opponents additionally claimed that the increase of nuclear reactors would have little, if any, effect on the proliferation of nuclear weapons, and that the continued development of nuclear power is vital to national and international socio-economic - and therefore political - health. The ethicists participating in the consultation were left somewhere in the middle of the debate, hesitant to 'take sides', and becoming more and more convinced of the wisdom of the WCC's non-commital approach to the nuclear question. The result of the consultation, according to one reporter, was to leave 'those who had planned the consultation ... with egg on their faces'.[38]

38. Sheila Collins, op.cit., p. 50.

Nevertheless, the Church and Society Division persevered in its basic policy recommendations, and, after only minimal revisions, presented the March 2-4, 1976, meeting of the NCC Governing Board with a proposal calling for a moratorium on the use of plutonium. While the case against plutonium had received a well-publicised boost shortly before the Governing Board was convened, with the resignation of three Senior Engineers from General Electric's Nuclear Division and a Project Manager from the N.R.C., over the problems of nuclear safety, the value of the moratorium proposal was severely criticised by three well-respected delegates to the Governing Board. Preston Williams argued to the Board that the proposal relied too much on fear; Roger Shinn cautioned the Board not to follow the mistakes made by church fathers regarding the work done by such noted scientists as Galileo; and Margaret Maxey expressed concern that the moratorium could stop a development that could 'place us at the threshold of a new level of cultural evolution'.[39] After what has been described as a 'heated and prolonged debate', the Governing Board finally passed a resolution which not only called for a moratorium on the commercial processing and use of plutonium as an energy source, but also recommended an immediate stop to the building of demonstration plutonium breeder reactors. Although an NCC resolution has less impact than a policy statement, it was seen as significant that the anti-plutonium resolution had passed by an almost unanimous vote by the board. In addition, the resolution did carry with it a call to the NCC member churches to 'engage in a study leading to the formulation of a final/

39. James Wall, 'Making a Decision on Plutonium', <u>Christian Century</u>, No. 7, March 3, 1976, p. 187.

final policy statement on the matter no later than Spring 1978'.[40] The Board was apparently convinced that the intervening two-year study programme would permit the public to gain greater knowledge of both the dangers and potentials of plutonium as an energy source, and would put the NCC in a more enlightened posture to make a creditable policy statement on the issue. As it was, the Board emphasised that this present resolution was only against the use of plutonium, and was not meant 'to condemn nuclear fission as a power source'.[41]

In anticipation of the Spring 1978 deadline, and a Governing Board meeting scheduled for May 1978, the Division of Church and Society sponsored an energy ethics consultation in October 1977. Attending this consultation were 120 individuals representing a wide array of disciplines: theology, ethics, labour, energy industries, technical sciences, social sciences, economics, and environmental and consumer interests. At the centre of the consultation was the Church and Society's Committee on Energy Policy, with the responsibility to synthesise the information produced by the consultation, and draft a policy statement for the Governing Board.

The report that was ultimately produced by the committee, the 'Proposed Policy Statement on the Ethical Implications of Energy Production and Use', not only recommended energy conservation projects, development of new energy technologies that use renewable resources, and international sharing of resources and energy technologies, but also called for a United States national energy policy 'which will not/

40. James Wall, 'A Plutonium Moratorium', <u>Christian Century</u>, No. 9, March 17, 1976, p. 243.

41. James Wall, 'NCC Says No to Nuclear Power', op.cit., p. 579.

not need to utilise nuclear fission'.[42] These recommendations were presented after the report had critically analysed five major areas of ecumenical concern in the energy debate. The first of these areas dealt with the inescapable fact that a world energy crisis does exist. The report claimed that regardless of one's perspective, whether pro-nuclear energy or not, energy issues are urgent and demand serious attention from both church and society. A major concern expressed in this regard was that due to the interrelationship of society and its energy systems, inaction or wrong decisions could result in disaster.

The second major section of the report considered the theological framework of energy issues. Here, the Biblical theme of humanity's inter-connection with all creation -organic and inorganic - was stressed, with sin being defined as mankind's 'perversion of dominion into domination'.[43] The report called upon the churches to act in the redemptive spirit of Jesus Christ by promoting social, economic, and environmental justice in energy decisions. The concept of 'neighbour' was expanded to include 'all humans in past, present, and future generations, as well as the rest of creation',[44] and Christians were urged to exercise great care and responsibility toward all their 'neighbours' when making future energy decisions, and to resist being led by the use of technological power for its own immediate interests.

42. John Maust, 'NCC: Nuclear Reactions But No Ecumenical Fusion', Christianity Today, June 8, 1979, p. 46.

43. As quoted in Bruce Birch, 'Energy Ethics Reaches the Church's Agenda', Christian Century, No. 35, November 1, 1978, p. 1035.

44. Ibid., p. 1036.

The third area of investigation was in the development of an ethic of ecological justice. Here, the welfare of the human community was perceived as being inherently tied to the welfare of the biosphere. The report advanced three values against which energy policies and technologies could be measured for their consistency with this goal of ecological justice: sustainability, equity, and participation. Sustainability referred to the earth's limited capacity to provide resources and to absorb the pollution resulting from their use, and was seen as requiring that the biological and social systems, which nurture and support life, be neither depleted nor poisoned. Equity referred to the fair distribution of resources on the basis of need, and was presented as pertaining to not only today's generations, but to those yet unborn as well. Participation referred to the absolute necessity of each individual member of the community having the opportunity to become involved in the determination of energy policy, as well as in the structuring of values which would ultimately guide the utilisation of such policy.

The fourth major section of the proposed policy statement concerned the inherent element of risk in any energy technology. Of all the energy alternatives presently available, however, nuclear technology was the only one judged as being unacceptable, as it raises the very real possibility of irreversible damage to the biosphere. Further, it was concluded that because many of the social costs of high-risk nuclear technology are postponed to future generations, with the benefits accruing to the present, an energy policy concerned for ecological justice should seek the development and use of more immediate, lower-risk technologies, such as solar energy. This section also called for the development of an ethic of sharing, and underscored the necessity of stringent energy/

energy conservation measures in the developed energy-rich nations of the West.

The fifth major section reiterated the values of sustainability, equity, and participation, and argued that the objects of these goals could be realistically applied in the formulation of an alternative energy policy. In regard to the specific decision-making processes in matters of United States energy policy, the report called for 'a national commitment to anticipate serious threats posed by certain technologies to the quality of the community of life and to design an appropriate energy policy. The process of anticipating threats must include', the report continued, 'technological and social impact assessment.'[45] In this regard, technological assessment would include an analysis of the effects of particular energy technologies on society, the environment, and the economy; while social impact assessment would measure the effects of particular energy policies in the areas of community development, employment, industrial development, land use, health, and community services.

A final section of the proposed policy statement posed a challenge to the churches to participate in shaping an ecologically just society. This challenge was set in primarily visionary terms, and concluded with the dream that:

> 'Such a society will respect the limits of creation - the fallibility of human beings, the finite supply of resources, the inability of the natural world endlessly to absorb unnatural substances, and the reality that everything and everyone is connected with every other one in the community of life.
>
> Such/

45. Ibid., p. 1037.

> Such a society will respond to the demands of equitable distribution by ensuring that finite resources are thoughtfully conserved so that they may be equitably shared to meet the needs of all persons, now and in the future.
>
> Such a society will ensure that satisfaction of human needs takes immediate priority over the satisfaction of anyone's desires, and that the dignity of each individual is honoured by providing opportunity for all persons to participate responsibility in decisions which will affect their individual lives and the common good.' [46]

The Church and Society Division presented its findings to the Governing Board of the NCC at the May 1978 General Meeting, for a first reading. A second reading, and initial debate of the proposed policy statement, occurred at the following meeting of the Governing Board in November 1978. However, the formal debate and deciding vote on the proposed policy did not occur until the following General Meeting in May 1979. Just over a month before this meeting took place, the Harrisburg-Three Mile Island area of Pennsylvania faced the possibility of a major nuclear disaster. This occurred when several standard and emergency cooling systems in a nuclear reactor malfunctioned, almost causing a core meltdown and a massive release of radioactivity in a densely populated area. On April 6, 1979, the faculty of Lancaster Theological Seminary, located just 23 miles from the damaged nuclear plant, published a unanimously adopted statement that identified four 'structures of evil' which were said to have become apparent as a result of the reactor accident.[47] These four structures were defined/

46. Ibid., p. 1038.

47. For excerpts from the Lancaster Theological Seminary's Statement ~~see~~: 'A Statement on the Three Mile Island Nuclear Accident', Anticipation, No. 26, June 1979, pp. 77-79.

defined as: the American standard of consumption, or 'selfishness'; the unthinking trust in technology, or 'idolatry'; the economic and political structures that benefit financially from nuclear powers, or 'greed'; and, the pervasive sense of impotence which blocks meaningful political action, or 'apathy'. The statement concluded with a plea for 'a moratorium on construction of all nuclear power plants', and for a phasing out of existing plants 'as rapidly as possible until there can be solutions to the problems of nuclear waste disposal and accidents'.[48]

The impact of the near disaster at Three Mile Island, and of the resulting Lancaster Seminary's statement on nuclear power, on the May 9-11 meeting of the NCC Governing Board is impossible to assess. Obviously, neither event detracted from the anti-nuclear position of the Church and Society's proposed policy statement. In fact, the tone the General Meeting was to take became somewhat apparent on May 8, when, in a pre-meeting session, the NCC Executive Committee waived the first reading of the proposed statement, thereby shortening and simplifying the procedure for formulating formal NCC policy. Additionally, the Governing Board twice changed its agenda to allow more time for the energy policy debate. The debate itself lasted the full three day period, and concluded with a 120 to 26 vote in favour of passing the policy statement - well above the necessary two-thirds vote required to establish NCC policy.

As previously mentioned, the new NCC policy not only supported the earlier recommendation for a ban on the commercial use of plutonium/

48. James Wall, 'Grace and the Nuclear Problem', Christian Century, No. 15, April 25, 1979.

plutonium, but also opposed the further development or building of any new nuclear power facilities. Citing a moral responsibility to 'work together as accountable stewards of the whole earth and as bold advocates for fairness in the human community', the Governing Board concluded in its passage of the policy, that the problem of nuclear waste and the potential for human mechanical accidents were too great to justify the risk of continued nuclear-fission development.[49] Shortly after passage of the new energy policy, NCC President M. William Howard said that the statement was an ecumenical signal 'to immediately move to take significant steps toward elimination of dependence on nuclear energy'.[50]

The British Council of Churches (BCC)

On November 10, 1976, the Rt. Rev. John Habgood, Bishop of Durham, delivered a lecture at the Institute of Strategic Studies in London on 'The Proliferation of Nuclear Technology'. This lecture was presented on behalf of the Council on Christian Approaches to Defence and Disarmament (CCADD), and was subsequently published by the BCC. Basically, the Bishop's comments consisted of two major thrusts: that the future energy requirements for the United Kingdom are clouded by a 'maze of uncertainty'; and that the risks associated with supplying future energy needs through nuclear means outweigh the possible advantages, at least in the foreseeable future. The Bishop concluded his talk by citing three 'sensible' reasons for presently refraining/

49. James Wall, 'NCC Says No to Nuclear Power', op.cit., p. 579.
50. John Maust, op.cit., p. 46.

refraining from the further development of nuclear energy technology. The first reason was that such a move away from nuclear power would free the resources required to develop alternative energy sources. The Bishop claimed that because the United Kingdom could not afford to develop both a nuclear programme and an alternative source of energy at the same time, it should choose the alternative course now, while stocks of coal and oil will allow it. The second reason given was that even if it were discovered later that no viable energy alternative to nuclear power exists, Britain would then be in an opportune position to buy the appropriate nuclear technology from other industrialised countries, at perhaps a cheaper price. The Bishop's final point was that an early opting out of the nuclear programme would also be financially sound in that it would save Britain the organisational costs and 'difficulties' that accompany the development of any new massive scale industry. Bishop Habgood's closing statement claimed that the present doubts surrounding nuclear technology should be regarded as important reminders 'of the need to recover a sense of restraint in many other features of our social and political life',[51] and urged that the United Kingdom take the 'courageous political decision' to not proceed with expanding its nuclear energy programme at this time.

One obvious consequence of Bishop Habgood's lecture was to help set the mood for the BCC's two day public hearing on the Government's proposal to build a commerical fast breeder reactor (CFR-1). This hearing took place shortly after the Bishop's public statement on/

51. John Habgood, The Proliferation of Nuclear Technology (BCC, London, 1977), p. 14.

on nuclear power, and was held in response to a number of calls for a public debate on nuclear energy. One such call had come from the General Assembly of the Church of Scotland, which, in its May 1976 Deliverances, urged 'the British Council of Churches to convene an ecumenical hearing in this country on the scientific, technical, and moral issues of the expansion of nuclear power, especially on the introduction of the fast breeder reactor'.[52] The BCC hearing additionally stemmed from: WCC prompting for more ecumenical involvement in the nuclear energy debate; the British Government's call for a public debate on nuclear energy; and widespread public concern arising from the findings of the Royal Commission on Environmental Pollution, as published in its Sixth Report of September 1976.

The purpose of the CFR-1 Hearing, as stated by Bishop Hugh Montefiore, Chairman of the Hearing, was not to pass judgement on either Britain's nuclear programme in general, or even the CFR-1 proposal in particular, but was 'to ventilate the underlying issues on a very broad front - goals and needs, risks, feasibilities, alternatives, investments ...'.[53] Although the hearing was originally scheduled for 1977, it was moved forward to mid-December 1976, after Mr. Tony Benn, Secretary of State for Energy, had made it clear that a hearing after that date would have little impact on the CFR-1 decision-making process. The method adopted for the hearing was to invite interested/

52. Church of Scotland, 'Deliverances of the General Assembly of the Church of Scotland', Reports to the General Assembly with the Legislative Acts 1976, (Blackwood and Sons, 1976), p. 12 (coloured section).

53. Hugh Montefiore and David Gosling, eds., Nuclear Crisis: A Question of Breeding (Prism Press, London, 1977), p. 165.

interested parties to submit statements of 500 words to the hearing panel. The panel, representing a wide range of expertise in various aspects of nuclear energy, would then cross-examine the individuals on their submissions. The chairman invited members of the public to participate by sending him written questions which he would then put to the witnesses. Ultimately, a total of 59 submissions were presented to the panel, and some 30 witnesses offered themselves for cross-examination.

The CFR-1 Hearing lasted a total of ten hours, stretching over a two-day period, and was divided into four sessions. Each session was devoted to a particular aspect of the nuclear energy issue, so that the hearing eventually covered the topics of: future energy needs - projected to AD 2000 and to AD 2050 -; the financial-economical-technological feasibility of bringing a commercial fast breeder reactor into operation; the potentiality of various energy alternatives, and the effect that a commitment to the development of CFR-1 would have on the nation's ability to investigate alternative sources of power; and, an evaluation of the manifold risks inherent in fast breeder technology, as well as the implications of a 'plutonium economy'. The proceedings of the hearing were later published by the BCC, and were generally favourably received by both sides of the nuclear energy debate as 'a balanced contribution to a debate which was becoming increasingly polarised'.[54] One apparent contribution of the hearing to the nuclear issue was to publicly expose what Professor Whyte termed 'the two voices of Science'. Not only had the submissions and witnesses/

54. David Gosling, 'The Nuclear Debate in the U.K. and the Contribution of the British Council of Churches', (BCC, London, 1979), p. 2.

witnesses expressed widely differing viewpoints, but there was also a great deal of 'highly informed disagreement' among the scientific community over the complexities of nuclear power - with conflicting scientific analyses presented to interpret similar phenomena. Additionally, the hearing provided the valuable function of placing the complexities of nuclear energy into the wider ecological realm. As emphasised by Chairman Montefiore, 'This public hearing is part of the council's attempt to minister to society ... human beings dare not place in jeopardy the future of this planet ... man had a genuine concern and respect for nature's inherent values. If he is made in the image of God, he must behave in a God-like or responsible manner.'[55]

Formal reaction of the BCC to the testimony presented at the CFR-1 Hearing was delayed until the council's next meeting in April 1977. Here, the major arguments both for and against the CFR-1 proposal were analysed at length, with the wider technical, economic, and social ramifications receiving special emphasis. In addition, the council underscored the interrelationships of technology and society, and cited nuclear technology as posing particularly sharp questions 'concerning the character of man's responsibility to his fellows, to the natural world and to the future'.[56] Maintaining an ethical concern to 'enlarge the range of possibilities open to those who come after us, and to avoid policies which will diminish those possibilities',[57] the council concluded that 'the government's/

55. Montefiore and Gosling, eds., op.cit., pp. 163-164.

56. Assembly of the British Council of Churches, 'British Energy Policy and the Fast Breeder Reactor', (BCC, London, 1977), p. 1.

57. Ibid.

government's energy policies should not include the fast breeder reactor until such time as some at least of the problems which cause disquiet have been resolved'.[58] Two particularly disquieting problems identified by the BCC Assembly, involved the satisfactory solution to the problem of radioactive waste disposal, and the challenge offered by a collaborative international development of the fast breeder reactor to avoid the wasteful duplication of resources. The assembly vowed to remain firm in its decision against the development of CFR-1, 'until further progress has been made in respect of both these matters'.[59]

At this same assembly, the council urged the British Government to improve its forecasting of future energy needs, and to give urgent priority to the need for a comprehensive long-term energy policy. The council also passed a motion authorising the BCC to participate in the forthcoming Windscale Public Local Inquiry. This inquiry was to concern a British Nuclear Fuels, Ltd., application to build a thermal oxide reprocessing plant (THORP) at Windscale, and was scheduled for September 1977.

The submission of the BCC to the Windscale Inquiry contained two major thrusts: the moral issues raised by the advanced nuclear technology utilised by a reprocessing plant; and the attendant social and environmental issues raised by the mere existence of such a plant. As in the public hearing on CFR-1, the BCC emphasised in its Windscale submission a primary concern 'to elucidate the issues of technical and moral judgement implicit in current developments in nuclear energy, so/

58. Ibid.

59. Ibid., p. 5.

so as to enable policy-makers and citizens alike to come to adequately grounded decisions concerning them'.[60] Nevertheless, the BCC also recognised a clear responsibility to state its ethical opposition to the THORP application. This opposition was entirely consistent with its earlier resolutions regarding the CFR-1 proposal, and was based on six major considerations. The first of these was the significant degree of disagreement among experts relating to relevant technical issues, particularly with regard to the anticipated increase of genetic damage arising from increased radiation levels, and the projected forecasts of the United Kingdom's future energy demand. The second consideration involved the perceived folly of developing an oxide reprocessing facility before a satisfactory method of radioactive waste disposal is developed. The third objection concerned the immorality of developing technology which would significantly increase the burden of responsibility and risk to our descendants, particularly when other options are available. The fourth concern was over the increased risk of nuclear weapons proliferation, and the perhaps unacceptable limitations on civil liberties that would accompany the increased production and reliance on plutonium. The fifth consideration involved the accompanying foreclosure of alternative, less dangerous energy options with the decision to heavily expand the nuclear energy industry in the direction of spent fuel reprocessing; while the final objection claimed the relative insignificance of the arguments advanced in support of the THORP application, which were mainly based on economic criteria, such as employment opportunities and increased /

60. British Council of Churches, 'Closing Statement at the Windscale Public Local Inquiry', (BCC, London, 1977), p. 1.

increased foreign earnings. The submission of the BCC concluded with an evaluation and ranking of the various moral presumptions involved in its ethical assessment of THORP. In this evaluation and resulting moral hierarchy, a higher priority was attached to those presumptions relating to the continuity of life and to the physical integrity of individuals, than to those presumptions which were concerned with the achievement of positive goals for individuals and for society. 'Thus', the BCC concluded:

> 'the risk of physical damage to persons now alive and yet to be born, whether somatic or genetic, through radiation, should represent a consideration of major significance, and should take precedence over the objective of avoiding social or economic problems arising from a forecast energy gap. The existence of the unsolved problem of waste disposal, and the risk of proliferation attending on the "plutonium economy" both represent types of this risk, and as such represent in our judgement overriding considerations against THORP in present circumstances.' 61

After the Windscale Inquiry, the BCC established a 'part-time' Nuclear Energy Group for the purpose of keeping the council informed of current developments in the nuclear energy debate. This group, which was designed primarily as an interim measure, has been recently replaced by a larger, more comprehensive Energy Group, which has the responsibility of monitoring the various socio-political problems posed by energy needs in the United Kingdom. As stated by David Gosling, the BCC's working assumption in establishing this larger Energy Group is the probability that 'by the 1990's almost all major social problems associated with big cities will be shaped to a large extent by energy availability and prices, and it is therefore incumbent on the churches/

61. Ibid., p. 7.

churches, by viture of their prophetic calling, to anticipate and respond to what is likely to happen towards the end of the present century and beyond it'.[62] As designed, the Energy Group is intended to move in that direction.

In keeping with the stated pledge to keep active in the nuclear energy controversy, the BCC responded to the British Government's Consultative Document on Energy Policy on July 20, 1979. The basic position of the BCC was that the document was 'far too much oriented towards the needs of the supply industries, and in particular their need to expand'.[63] Citing a governmental responsibility to the public to insure that energy needs are not overestimated, and, therefore, that precious resources are not wasted by providing capacity which will never be used, as well as important alternative energy investments not being needlessly siphoned away; the BCC urged the government to place more emphasis on energy conservation, by way of economical incentives, and on the development of alternatives that might reduce energy needs. The BCC also noted that the consultative document omitted any consideration of the effect of British energy policies on Third World nations, and requested that the government look more carefully at this issue.

The BCC has also acted recently to keep the issue concerning the development of the commercial fast breeder reactor alive. Responding to a previously stated governmental intention to hold an inquiry on the matter, the BCC urged the government to sponsor a planning inquiry/

62. David Gosling, op.cit., p. 5.

63. Andrew Morton, et.al., Letter to Mr. David Howell, Secretary of State for Energy, July 20, 1979.

inquiry commission, or an analogue to it, instead. In making this recommendation, the BCC noted several adverse results of the Windscale Inquiry, and suggested that an issue as crucial as CFR-1 warrants:

> 'an effort to involve this whole community ... The argument for this is not only that this decision will affect the future of all sections of the community, but also that decisions concerning recent echnologies of this kind, with their large scale and great complexity, call for new ways of combining the great range of relevant skills and insights which are diffused throughout the community, of which some are technical and others are ethical'. 64

French Protestant Federation (FPF)

The FPF entered the nuclear debate in September 1977, when its Council instructed its Social, Economic and International Commission to study the problems of nuclear energy technology. The commission spent the following six months gathering information on the issue, and interviewing experts involved in the nuclear debate. Its resulting report, adopted and published by the FPF in April 1978, not only included a critical review of the global implications of nuclear power, but also examined several perceived weak points of the existing French nuclear programme.

In its consideration of the global ramifications of nuclear technology, the FPF emphasised the wider scientific-technological-military context, of which nuclear energy was seen as a "striking" but not "unique" example of high technological risk. The FPF also questioned the nuclear industry's assumptions regarding future worldwide/

64. Andrew Morton, et.al., Letter to Mr. Michael Haseltine, Secretary of State for the Environment, July 20, 1979.

worldwide energy demand, and pointed to several unavoidable risks that would result from a global commitment to advanced technology, epitomised by nuclear energy generation. These risks included the difficulty of ensuring the absolute security of nuclear installations, the storage of highly radioactive wastes until safe methods of elimination are developed, the ever-present danger of the proliferation of nuclear weapons, and the danger of increasing surveillance of world populations and the attendant use of repressive measures by governments to off-set some of the previous risks. Against the severity of these global risks, the FPF concluded that 'it is urgent for our societies to reflect on the ways by which mankind can make decisions without becoming the slaves of economic or technical imperatives as defined by groups of experts'.[65]

On the subject of the French nuclear programme, the FPF noted three major weaknesses. The first was that the rapid acceleration of the programme, combined with the commitment to an untested and unproved pressurised water reactor, has begged failures and accidents. The second weakness was that the French capacity for spent fuel reprocessing is hopelessly insufficient. The final major criticism was that the French industry had initiated an ambitious breeder reactor programme without first adequately assessing the manifold dangers involved. The FPF concluded its report by recommending the adoption of a more moderate pace by the French nuclear industry, with the government initiating a programme of energy rationing to avoid a possible energy shortage. The FPF also insisted that all parties recognise that any/

65. French Protestant Federation, 'The Question of Nuclear Energy', <u>WCC Exchange,</u> No. 3, May 1978, p. 4.

any nuclear programme is only, ultimately, a '... stage towards the only really unlimited energy in the human time scale, i.e. solar energy'.[66]

Evangelical Church in Germany (EKD)

In May 1978, the Council of the EKD published a statement regarding the role of nuclear energy within the larger energy debate. Claiming that the continued development of nuclear energy would lead to a long-term commitment to this 'hazardous' type of energy generation, the EKD advocated several methods of energy conservation to allow for a delay in a global commitment to the nuclear path. It was the expressed hope of the EKD Council that such a delay would allow for 'the development of new sources of energy and of energy-saving technologies ...' which would 'no doubt enlarge the room for manoeuvre in energy policy'.[67] Christians were particularly requested to accept the discipline and sense of responsibility called for by a more economical use of energy. Until conservation measures can take effect, and alternative methods of energy production were economically available, the EKD approved the limited use of nuclear reactors to guarantee the availability of required energy supplies.

In a discussion of the wider social context of energy issues, the Council of the EKD pointed to what it considered to be the four 'great dilemmas for the future'. These were defined as: the limits to technical and rational control of life; the limits to material progress/

66. Ibid., p. 9.

67. Council of the Evangelical Church in Germany, 'Statement on the Present Energy Debate', WCC Exchange, No. 3, May 1978, p. 2.

progress; the limits to nation-state thinking; and, the limits to our exploitation of nature. 'We are caught up in a crisis concerning the whole meaning of human life as such', the council concluded, with 'new meaning for human life within its limits only coming from God'.[68] The EKD perceived the nuclear energy dilemma as one of the opportunities for mankind to recognise its limited possibilities in the world, and to willingly accept these limitations realistically.

In a subsequent article on the threat of nuclear weapons proliferation, due to the increased development and widespread use of nuclear energy technology, the EKD warned that it could very well be our 'technical progress, wealth and profit-thinking that will lead to a final contamination of nature ...'[69] Aruging that because God has entrusted nature to mankind's care, the EKD claimed, therefore, that it is our primary responsibility not to destroy it. Consequently, an immediate de-emphasis of nuclear energy was presented as an essential part of our God-given responsibilities.

Independent British Church Groups

The Church of Scotland's initial mention of the nuclear energy controversy came in the Church and Nation Committee's report to the General Assembly in May 1975. In this report, the committee noted, among other things, that the four-fold increase in the price of oil had driven many countries to increase their nuclear power capacity, even though several problems, such as the disposal of radioactive/

68. Ibid., p. 3.

69. Klaus Roth-Stielow, 'Grundgresetz und Atomrecht', Evangelische Theologie, January/February 1979, p. 76.

radioactive wastes, remained unsolved. The committee suggested that in light of these persistent problems, '... there is much to be said for moving towards a society in which energy demands are brought into balance with sustainable non-depleting sources of power'.[70]

In its report to the following General Assembly in May 1976, the Church and Nation Committee enlarged upon its previous statement by summarising the proceedings of the WCC's Hearing on Nuclear Energy held at Sigtuna, Sweden. After emphasising four particularly controversial aspects of the nuclear energy debate surrounding the development of commercial fast breeder reactors - increasing scale of risks, divided technical opinion, great possibilities for energy conservation and coal reserves, and need to develop non-depleting energy systems - the committee recommended a British ecumenical hearing on the subject of the proposed development of CFR-1. The committee also suggested the publication of a summary of the Sigtuna Hearing, and concluded its report by emphasising 'the need to sustain and intensify present energy conservation measures and increase research and development into non-nuclear sources of power'.[71] In its following deliverances, the General Assembly approved of the committee's recommendations, and urged the BCC to convene an ecumenical hearing on the CFR-1 proposal.

In order to encourage ecumenical involvement in the nuclear power debate, the Science, Religion and Technology Project of the Church of/

70. Church of Scotland, 'Report of the Church and Nation Committee', Reports to the General Assembly with the Legislative Acts; 1975, (Blackwood and Sons, 1975), p. 127.

71. Reports to the General Assembly with the Legislative Acts; 1976, op.cit., p. 123.

of Scotland published, in mid-1976, an agenda that simply and comprehensively identified the major theological issues implicit in the nuclear energy choices. Included in this agenda were the broader ecological concerns of creation, stewardship and responsibility; a Christian doctrine of man; a theology of hope; structures of power; and the anxieties of the global community. Later in this same year, the Church of Scotland held a private meeting with energy experts in Edinburgh. As a direct consequence of that meeting, the Church published a statement of concern which defined four perceived requirements of the government's approach to the dilemmas of nuclear technology. These four requirements were: the need for the UK to strive for energy conservation; the need for research into the feasibility of developing alternative sources of energy; the need for public disclosures concerning the manifold implications of a nuclear programme and, particularly, the implications of the proposed commercial fast breeder reactor-programme; and, finally, the need for church involvement in the moral issues raised by the UK's current energy policy.

Expanding on the theme of ecumenical involvement in the general issues of ecology and the specific concerns of nuclear power, the Church and Nation Committee sponsored a public meeting on 'Energy Needs, the Nuclear Option and Its Consequences' in February 1977. The stated object of the meeting was 'to inform the public on certain issues relating to energy policy in the UK', with the main point of inquiry being 'whether the UK should at this time commit itself to a long-term programme aimed at the use of nuclear power to meet the country's energy needs'.[72] The committee had solicited for written/

72. J.B. Smith, 'Opening Remarks', in Society, Religion and Technology, Energy Needs, the Nuclear Option and its Consequences (SRT Project, Edinburgh, 1977), p. 4.

written statements from concerned groups and individuals prior to the meeting, and had divided these into four major topics of discussion. Each topic was then assigned to a separate session of the meeting, with the individual sessions being introduced by an invited paper. An opportunity for questions and/or comments from those attending followed each session. The meeting was well received by both sides of the nuclear energy controversy, and was generally hailed as giving a well-balanced account of the four topics covered, which included energy needs, fast reactors in Britain, alternative energy sources, and ethical dimensions of the energy choice.

The Church of Scotland made yet another contribution to the wider environmental ramifications of the development and use of advanced technologies, epitomised by nuclear technologies, when it published Ecology, Equity and Ethics in September 1977. This publication was composed of four lectures delivered by Colin Pritchard, the Director of the Society, Religion and Technology Project, before the American Summer Institute at St. Mary's College in July 1977. Pritchard's lectures covered such topics as mankind's responsibility for, and in, the natural world; the human potential for an 'economical' response to the environmental crisis; recent developments in the modern sciences that shift away from the mechanistic and deterministic view of the universe; and man's 'evolutionary responsibilities' which must ultimately bring him face to face with the limitations of his scientific method of inquiry. The continuous thread that ran throughout the lecture series appears to be the absolute inseparability of freedom and its concomitant responsibility - that for every freedom there is a matching responsibility. Pritchard concluded his talks with the question: 'Is the price being paid by the world's people for Western freedom to be profligate, to exploit resources without regard/

regard either to exhaustibility or to need but only to profit - too high?'[73] His resounding answer 'I think so!' not only contained his understanding of the principles upon which a just society should be founded, but also held obvious implications for what are justifiable and sustainable technological developments.

Colin Pritchard, on behalf of the Church of Scotland, elaborated on his perceptions of what would constitute a global society founded on the principles of justice and sustainability, in his 1977 lecture given at Edinburgh University titled 'From Here to Where?' Pritchard's conclusion, after applying a 'just' and 'sustainable' yardstick to advanced technological developments in the Western world, was that Western man must now '... at least pause and take stock'.[74] This theme of technological cessation and societal evaluation was also advised in the Church and Nation's comments to the Secretary of State for Energy, in response to the government's Green Paper on Energy Policy (CMND 7101). Here the committee concentrated on the potential slowing effects on technological development and utilisation, that energy conservation measures and modified energy use patterns, include.

The Church of Scotland's interest in keeping ecumenical interest in the nuclear energy debate alive was evident in the May 1979 Deliverances of the General Assembly. As well as drawing attention to the preparatory readings for the WCC Conference on Faith, Science and the Future, and approving the BCC's creation of the Nuclear Energy Group, the assembly adopted a Church and Nation Committee/

73. Colin Pritchard, Ecology, Equity and Ethics (SRT Project, Edinburgh, 1977), p. 45.

74. Colin Pritchard, From Here to Where? (SRT Project, Edinburgh, 1978), p. 10.

Committee proposal to sponsor a seminar exclusively devoted to future energy demands. This seminar was to key on the recently publicised findings of the International Institute for Environment and Development, which concluded that official British energy forecasts have greatly over-estimated future energy requirements. As noted by the Church and Nation Committee from the report's statistics, '... if these forecasts remain unchallenged, well over £1 Billion a year could be spent unnecessarily for the rest of this century on power station construction alone'.[75] The General Assembly requested the Church and Nation Committee to make a full report on the various matters raised at this seminar, as well as the proceedings of the WCC World Conference, tothe 1980 General Assembly.

Three other British Church groups which have contributed to the dissemination and understanding of the nuclear energy complexities at the parishioner level, have been the Church of England, the Religious Society of Friends (Quakers), and the Roman Catholic Church. While none of these Church groups have taken a specific pro- or con- stance on the continued development and use of nuclear energy technology, they have all recommended a future energy policy predicated on caution towards advanced technological processes, including a limited use of the nuclear option.

A major study of the risks inherent in, and the ramifications of, fast breeder technology was published by the Church of England in 1977. In this publication, Nuclear Choice: A Christian Contribution to the/

75. Church of Scotland, 'Report of the Church and Nation Committee', Reports to the General Assembly with the Legislative Acts; 1979, (Blackwood and Sons, 1979), p. 99.

the Debate on the Fast Breeder Reactor, the church set the ethical tone of the CFR-1 controversy by asking what it considered to be the crucial moral question: 'Will a fast breeder energy system, of which CFR-1 is the demonstration model, help or hinder man in becoming more fully human?'[76] After summarising the various arguments presented both for and against breeder technology, the church concluded that the social and technological risks require '... more time for issues to be clarified before major decisions are made, and that the public is made aware of the real issues before government finally makes up its mind'.[77] Some of the risks the church felt were worthy of special attention and investigation were the materials problems in breeder fuel assemblies, the inability to safely dispose of highly radioactive wastes, the possibilities of nuclear terrorism and/or the creation of a police state, the proliferation of nuclear weapons, and the fear that a commitment to breeder technology would preclude the development of alternative energy sources.

The British division of the Religious Society of Friends (Quakers) officially joined the nuclear energy controversy in February 1978, when it established a Nuclear Energy Group. This Group was composed of nuclear scientists and engineers, as well as individuals with non-scientific backgrounds, and was tasked to 'carry forward the thinking on this issue and present ... a report on the spiritual and moral issues on which the judgement of the Society should be sought'.[78] The/

76. Church of England, Nuclear Choice: A Christian Contribution to the Debate on the Fast Breeder Reactor (Church Information Office, London, 1977), p. 7.

77. Ibid.

78. Quaker Nuclear Energy Group, Nuclear Energy: What are the Choices? (Quaker Home Service, London, 1979), p. 1.

The initial report of the Nuclear Energy Group was presented to the Quaker yearly meeting in London, 1979. This report considered nuclear power in the context of global needs and dangers, rather than in terms of issues confined to the United Kingdom alone, and included two major parts. The first part was devoted to a non-technical outline of the major disputed points in the nuclear energy debate, and concluded with a critical analysis of four imagined types of response to the questions posed by the nuclear issue. These four responses were cited as: favouring the rapid expansion and development of nuclear energy; accepting the further development of nuclear energy with the utmost caution, and only as a necessary transitional measure to reliance on renewable energy sources; favouring a moratorium on the development of nuclear energy while conservation measures and the exploitation of laternative sources are carried out; and, rejecting any further development of nuclear power. Although the Nuclear Energy Group's report emphasised that 'none of these choices is safe',[79] the major criterion continuously stressed throughout the report for the proper assessment of nuclear energy was propensity for nuclear weapons proliferation. Thus, because the first two types of response enhance the risk of such proliferation, the report tended to reject them.

The second part of the Nuclear Energy Group's report dealt with the specific hazards entailed in nuclear energy development. Again, this section emphasised increased proliferation risk as a function of the global multiplication of nuclear reactors. Additionally, the section stressed the ever-widening gap between rich and poor nations, as a product of the use of advanced technologies by the affluent, and/

79. Ibid., p. 6.

and urged the proper and equitable use of the earth's resources. The report concluded that '... the risks associated with the use of nuclear power for civil purposes are such that this course could be accepted only with great caution',[80] and that a limited nuclear power programme could only be acceptable if 'the alternative were the failure to sustain the energy needs of the whole world'.[81]

A major contribution by the Roman Catholic Church in Britain to the atomic energy debate came with its publication, Nuclear Energy: A Christian Concern. Here, the problems of atomic weapons proliferation, radiation exposure and leakage throughout the entire nuclear fuel cycle, and the possibility of the curtailment of human rights were explored. In addition, the publication noted the various, less-risky alternatives to the continued development of nuclear energy technology. While the Catholic Church refrained from taking a definitive stand in this publication regarding the expanded use of nuclear energy, it did conclude its remarks by agreeing with statement from the Flowers Royal Commission report: 'We should not rely for something as basic as energy on a process that produces such hazardous substances as plutonium unless we are convinced that there is no reasonably certain economic alternative'.[82]

80. Ibid., p. 17.

81. Ibid.

82. As quoted in Sharon Triolo, Nuclear Energy: A Christian Concern (Catholic Truth Society, London), p. 4.

ETHICAL AND THEOLOGICAL CHURCH POSITIONS

Nuclear energy is often characterised in ecumenical discussions as offering mankind 'fantastic benefits', at a cost of 'unacceptable risks'. The overwhelming consensus among the various churches and church groups which have recently involved themselves in the energy issue, is that the hazards of atomic power are not being adequately dealt with by either the nuclear power industry or the national governments involved in the current expansion of nuclear energy technology. This has led to an almost unanimous ecumenical recommendation for a reassessment of the ultimate worth and desirability of nuclear energy, carried out at the widest possible societal level, before further commitments are made to the extension of atomic power. In fact, the only apparent exception to this ecclesiastical position has been the pronouncements of the Central United Protestant Church of Richland, Washington.[1] In 1976, the Central United Church issued a policy statement regarding nuclear energy which stated that:

> 'Future generations may condemn us more for too rapid depletion of irreplaceable coal and oil than for use of nuclear power ... We believe the moral responsibility of the Christian Church is to promote a non-violent society in which the people can be free from want, hunger and fear of war for energy resources. Therefore, suppression of development of any practical source of energy such as nuclear power becomes immoral.
>
> Nuclear/

1. Richland is the home of the Hanford atomic works - a major nuclear energy site in the United States, as well as the birthplace of the first atomic bomb. Included in the Central United Protestant Church's congregation are numerous nuclear scientists and engineers.

> Nuclear reactors are safe. Poverty is dangerous. We must do something about the causes of war. Nuclear power is our nation's best hope to avoid the darker world of civil chaos, unemployment and hunger'. 2

The most fundamental difference between the position taken by Richland's Central United Protestant Church, and, for that matter, the nuclear power industry in general, and the stand taken by the WCC, NCC, and BCC, is the perceived morality of taking risks. While the assessment of nuclear technology risks is currently a matter of intense debate, virtually all sides of the nuclear energy controversy agree that a certain degree of risk-taking is involved in the generation of atomic power. As discussed by Gerard Hughes, Professor of Moral Theology at Heythrop College, there are three basic ethical positions possible in regard to the risks involved in the development and use of nuclear energy. These are: to protect ourselves as much as possible against the worst possible outcome; to go for the 'big win', maximising our chances of the best possible outcome; or, to 'try to keep most of our cake, and have a fair chance of eating some of it as well'.[3] This final position, which is the one eventually recommended by Hughes, includes renouncing possible benefits in the face of extreme hazards. Or, to be more specific, this would involve delaying the development of plutonium until methods are found to '... control radiation-related disease, and control dangerous waste products'.[4]

2. As quoted by Margaret Maxey, 'The NCC and Nuclear Power: Continuing the Discussion', Christianity and Crisis, May 10, 1976, p. 109.

3. Gerard Hughes, 'Nuclear Power: Moral Issues', The Tablet, September 3, 1977, p.

4. Ibid.

A Theology of Ecology

The limits of the ethical continuum, along which responses can be given to any aspect of the environmental crisis, including the issue of nuclear energy, are defined at one extreme by Garrett Hardin's 'lifeboat ethics', and at the opposite end by Kenneth Boulding's concept of 'spaceship earth'.

Hardin, a Professor of Human Ecology at the University of California, has coined such phrases as 'social triage', 'lifeboat ethics', and 'environmental commons', to explain his ethic of survival in a world suffering from dwindling supplies of resources. Hardin's perception of the environmental crisis has led him to conclude that because the carrying capacity of the planet cannot sustain a global standard of living at par with the expectations of the Western nations, a world-wide competition for the earth's remaining resources is inevitable. This competition, he claims, will be similar to that of survivors of a shipwreck competing for places in a lifeboat. Here, he suggests, the military notion of 'triage' should be applied to ethically decide which nations are to receive adequate food and supplies. Although 'triage' stands for a method of deciding what combat casualties will get assistance and in what priority, its application to Hardin's lifeboat scenario is obvious: those who can survive, but only if immediate help is given, get the first attention; hopelessly (mortally) wounded are left to die; and the less seriously injured are given the necessary assistance, but later.

A further argument from Hardin's lifeboat perspective is that if exported technology or financial assistance is used to increase the carrying capacity of a 'hopeless' area, then either more individuals will eventually die than would if no assistance had been given, or the/

the lifeboat itself will ultimately become overcrowded to the detriment of all. Hardin graphically argues:

> 'In the ocean outside each lifeboat swims the poor of the world, who would like to get in, or at least to share some of the wealth. What should the lifeboat passengers do? ... If the poor are 'taken aboard', the boat swamps, everyone drowns. Complete justice, complete catastrophe ... For the foreseeable future, our survival demands that we govern our actions by the ethics of the lifeboat, harsh though they may be.' 5

Hardin has attempted to defend his lifeboat ethics by harkening to the experiences of the United States in Vietnam. There are limits, he suggests, to which anyone can help anyone else:

> 'And yet people say, "But how can you let them starve?" That looks like an innocent question, but I do not think it is so innocent. It implies that there is another option, that we can help them from starving, and even more, that we are the only ones who can help them from starving. It seems to me that trying to send food has a very close parallel in the military effort. In the case of the military situation, we once thought we could conquer the world. But after Vietnam we no longer believe it. We see that there are limits to what we can do. Yet we still are suffering from the belief that we can save the rest of the world. There is, I think, a real similarity in pride, in hubris, as the Greeks would call it, between the belief that we can conquer the world and the belief that we can save the world.' 6

Additional arguments presented by Hardin in support of his lifeboat thesis are that Third World nations themselves are largely responsible for their desperate plight, and that the poor can only be helped if they can help themselves. Hardin further makes a/

5. Garrett Hardin, 'Lifeboat ethics: the case against helping the poor', Psychology Today, No. 8, September 1974, p. 38.

6. Garrett Hardin, 'Lifeboat Ethics: Food and Population', in Ian Barbour, ed., Finite Resources and the Human Future, (Augsburg Publishing House, Minneapolis, 1976), p. 44.

a distinction between an act of 'charity', which is performed with far-reaching humane goals in mind, and 'mere amiability', which is short-term, bandaid assistance. In this regard, he perceives 'charity' as being the better course of action, even if it does mean leaving the poor to their own devices, and argues that 'when the object's real good cannot be achieved without inflicting pain and suffering, charity does not shrink from the infliction'.[7]

While Hardin does make some valid points in his arguments, as in insisting that 'trade' is preferable to 'aid', his ethical position is invalid for several reasons. One reason is that he has failed to acknowledge the connection between affluence and poverty. When Hardin claims that 'every Indian life saved through medical or nutritional assistance from abroad diminishes the quality of life for those who remain',[8] he is forgetting that it takes sixty or more times the resources to sustain one American life than it does to sustain one Indian. Clearly, Hardin's 'lifeboat' metaphor is dangerously inaccurate. It would be more correct if he were to refer to the West as afloat on a luxury yacht or an ocean liner. As stated by Walter Benjamin, 'ours is not a lifeboat ... we are a throwaway, non-returnable, planned-obsolescence society ... our worship of such luxuries as the private automobile, air conditioning, and marbleised beef indicates that we have done little in the areas of anti-pollution, recycling, energy reduction and simplification of life'.[9]

7. Ibid.

8. Garrett Hardin, 'Lifeboat Ethics: The Case Against Helping The Poor', op.cit., p. 42.

9. Walter Benjamin, 'A challenge to the Eco-Doomsters', <u>Christian Century</u>, No. 10, March 21, 1979, pp. 313-314.

Another inadequacy of Hardin's thesis is that it ignores the reality of global interdependence. Hardin fallaciously assumes a self-sufficiency of American 'prosperity', when in reality the United States is dependent on Third World nations for such basic necessities as oil, manganese, cobalt, chromium, titanium, tin, mercury, and asbestos. Hardin further ignores the economic principle that the higher the technology and the greater the consumption, the more vulnerable the society. This was well illustrated by the near panic of several Western nations over the OPEC oil embargo of 1973.

A further weakness of the 'lifeboat' ethic is that it stresses survival as the ultimate goal of life to the detriment of other values. This is particularly unconscionable when those in the lifeboat commit vast amounts of available resources to the defense of their privileged position, and when the proliferation of both armaments and waste are such that the global quality of life is consequently lowered.

A major concern generally overlooked by 'lifeboat' moralists is the potentially violent response on the part of the Third World to such a display of Western ethnocentrism. Hardin and his supporters seem to assume that the 'sacrifice nations' will simply disappear, ceasing to be a world problem. However, the global acceleration of violent retaliation by terrorist groups over the last decade appears to suggest that the poor may not be willing to quietly starve.

In conclusion, while Hardin's 'lifeboat ethics' do recognise the impending condition of global scarcity, and do imply the need for ecological reform, they accept immoral inequalities of resource distribution, and advocate extreme arrogance on the part of the rich. To call such a position as ethical, which Hardin does, is unthinkable from a Christian perspective. The choice presented to mankind today/

today by the environmental crisis is clear:

> 'Since the thirst for justice has been spread around the political desserts of the world, it must be either quenched or stifled; hence, we must either make a commitment to social and political justice in the world or be prepared to participate in its demonic denial. The latter course depends on applying ever-larger doses of terror and violence as oppressed people everywhere are being more and more awakened to the actualities of injustice. In such a world of aroused awareness there is no middle path. The issues are clear and we must be prepared to choose between oppressor and oppressed.' 10

While the ethics of the 'lifeboat' point in the direction of authoritarianism and oppression by the wealthy, the concept of a 'spaceship earth', as developed by Kenneth Boulding, seeks to align the wealthy with the poor and oppressed. Here, the condition of the earth is likened to that of a spaceship in regard to its limited amount of resources and its restricted carrying capacity. Boulding claims that basic to his 'spaceship' image is a shift in emphasis from 'conquest to conservation, and from an ethic of plunder to one of parsimony in order to husband and recycle precious resources'.[11] In support of his thesis, Boulding emphasises the message contained in the Sermon on the Mount - not for 'sectarian or monastic' lifestyles, or for 'eschatological interim', but for a 'necessary model' for human life. 'We had better learn to love our enemies', Boulding concludes, 'or we will destroy/

10. Richard Falk, This Endangered Planet (Random House, New York, 1971), p. 295.

11. Kenneth Boulding, 'This Wisdom of Man and the Wisdom of God', in Kenneth Boulding and Henry Clash, eds., Human Values on the Spaceship Earth (National Council of Churches of Christ in the United States, New York, 1966), p. 13.

destroy each other'.[12]

Fundamental to the 'spaceship' concept of earth is the holistic ecological principle of global interrelatedness. Boulding's assertions are that mankind must realise that the earth is a finite, closed 'spacecraft' in which all of life is interconnected; and that the value system which has made it possible for man to indifferently pollute his world, to compulsively consume material resources, to insensibly populate the planet, and to inequitably distribute global wealth so that more than half the people in the 'human family' go to bed hungry every night, must be changed. This change is seen as including a re-examination of how Western societies view the things they possess, and of the West's continuing desire to possess more of the world's goods and services. Also included in this required change of values are: a willingness to pay the price for environmental protection; a questioning of current growth rate policies which are predicated on ever-expanding production and consumption of goods and services; and the development of a world community that is based on the best interests of all people and nations, and on the absolute respect of the natural world and its ability to support life.

12. The relevancy of the Sermon on the Mount to global justice and ecological survival has also been stressed by E.F. Shumacher. Shumacher has observed that humans are 'poor, not demigods', that mankind has much for which to be sorrowful - in terms of environmental despoilation and injustice - and that we are hardly 'emerging into a golden age'. If we are to ever see right and justice prevail, Shumacher concludes, we will have to cultivate gentleness, rediscover the non-violent aspects of our spirit, and become 'peacemakers' once again. E.F. Shumacher, Small is Beautiful: Economics as if People Mattered (Harper and Row, Ltd., London, 1973), p. 156.

Also acknowledged by the 'spaceship' imagery is the ultimately social context of all human life. In thise sense, personalities are seen as being defined only in relation to the 'social ecosystem'. Whenever either the natural or social ecosystem is damaged, Boulding argues, the whole 'spaceship' suffers. This concept has also been stated by Joseph Sittler:

> 'What pollution is to natural ecology, injustice is to social ecology. What destruction or depletion of resources is to natural ecology, deprivation, degradation, enslavement are to social ecology. That we are bound to the earth is a fact: that we are bound to our fellow man is a fact. Nature in slow but relentless ways exercises reprisals if we ignore the first fact; history in equally relentless ways exercises reprisals if we ignore the second.' 13

From the perspective of the 'spaceship', then, the crisis of the environment has to do with nothing less than the whole of creaturely life - human and non-human, social and environmental. According to a rapidly developing school of Christian Environmentalism,[14] which has generally adopted the monumental visions of the 'spaceship' concept, only the broad scope of a religious doctrine can, if it will, grasp the total significance of such a crisis. The Christian environmentalists claim that both technological and political systems of thought are too restrictive for such an extensive application. Technological visions are seen as being too instrumental - preoccupied with the manipulation of the imminent and objectified - while political visions are said to be fragmentary, ephemeral, and ultimately/

13. Joseph Sittler, Jr., 'The New Creation', in Franklin Jensen and Cedric Tilberg, eds., The Human Crisis in Ecology (Lutheran Church in America, New York, 1972), p. 96.

14. See works by Joseph Sittler, Paul Santmire, Paul Lutz, Frederick Elder, Richard Baer, and John MacQuarrie.

ultimately contingent on the vagaries of worldly influence, irrespective of the good or evil that such influence represents. Religious vision, on the other hand, is presented by the Christian environmentalists as being inherently broader, deeper, more imaginative, and more inclusive of reality - both the mundane and the ultimate. Most adherents of the Christian environmental school also contend that the resources for such a values change, as is called for by the 'spaceship' concept, are already contained in the Christian tradition. John MacQuarrie, for example, has urged Christian theologians concerned with environmental issues to begin the task of 'renewal':

> '... By looking again into the Christian tradition, by inquiring at what points in the development of that tradition some elements in it came to be distorted through an exaggerated emphasis, and by asking what latent resources remain in the tradition that might respond to the needs of the present situation by introducing correctives and promoting the new attitudes demanded.' 15

The Christian school of environmentalism, which has recently developed in response to the global ecological crisis and to the challenges posed by the 'spaceship earth' concept, appears to contain three essential elements. These elements are: the re-unification of human affairs and nature in the inclusive category of the creation; the affirmation of the sovereignty of God over the whole of created being; and, the recognition of mankind's creatureliness, and of his responsibilities to the created realm. The major departure of Christian environmentalism from the more traditional theological modes seems to be its deliberate expansion of the scope of theological reflection/

15. John MacQuarrie, 'Creation and Environment', in David and Eileen Spring, eds., Ecology and Religion in History (Harper and Row, New York, 1974), p. 35.

reflection, which is usually limited to the affairs of humans, to include beings and events found in nature. The fundamental assumption of most Christian environmentalists is that the reality in which man has his being, and with which God is actively involved in, is both historical and natural. In this theology of ecology, nature is no longer regarded as it once was - 'the physical systems apart from man and his civilization'[16] - nor is history seen as excluding the dynamic interplay between mankind and the non-human environment. In the Christian environmentalist approach, nature is redefined as 'the living and the non-living; the human and non-human, plants as well as animals; sticks, air, water, stones; everything',[17] is seen as including both 'man and his works',[18] and is thought of in three aspects: 'wild, cultivated, and fabricated - the last two referring to nature as it is transformed by man into grain fields and flower gardens, skyscrapers and computers'.[19]

Christian environmentalism, then, perceives both human history and the natural environment of which man is a part, as being inextricably intertwined, such that the human and natural elements of earthly existence are distinguishable but not separable.[20] This appears to make perfectly good ecological sense. In this theology/

16. Jackson Lee Ice, 'The Ecological Crisis: Radical Monotheism vs. Ethical Pantheism', Religion in Life, XLV, Summer 1975, p. 206.

17. Richard Baer, 'Ecology, Religion and the American Dream', American Ecclesiastical Review, September 1971, p. 43.

18. Frederick Elder, Crisis in Eden (Abingdon Press, Nashville, 1970), p. 13.

19. H. Paul Santmire, Brother Earth (Nelson and Sons, Inc., New York, 1970), p. 15.

20. Ibid., p. 133.

theology, man's existence is reunited with the other creatures and inanimate nature - and all is subsumed under the primary and inclusive category of the created realm.

The second major element of modern Christian environmentalism, the absolute sovereignty of God over the whole of creation, has been described by Santmire as, '... the fundamental Biblical conviction that God both rules majestically throughout his creation, and rules majestically throughout his creation. The Biblical writers take seriously both the government of God and the world in which his rule holds sway'.[21] The rule of God is seen as having been established with his calling the world into being, and as having continued thereafter as the 'immediate source of all things'[22] of all existence and of all functioning. Similarly, the creation is perceived as 'an immense constellation of God's activity'.[23] There is, therefore, nothing in the created realm which is perceived as not being under God's rule, or of which He is unmindful, or to which His presence is not immediate. His rule is thought to encompass the whole of reality, with both human affairs and the natural environment being understood as coming under His command rather than man's. Joseph Sittler emphasised this point when he wrote, 'If men accept an understanding of the world as independent, there is no place for God's agency ... if men so radically historicise their understanding of the world as to bring all dynamics of world-happening within the orbit of man's/

21. Ibid., p. 104.

22. Ibid., p. 115.

23. Ibid., p. 99.

man's determination, there is no place for God's agency'.[24] In this conception, then, history must be bound to nature as a necessary component of God's agency. Or, as Santmire claims, even though nature appears to be a jumble of ambiguous, chaotic, unfinished, and sometimes horrific events, it is God and not man who ultimately binds these events together in that redemptive activity which moves the whole creation towards fulfilment in His kingdom.[25]

The major ecological importance of a theology in which God's absolute lordship is perceived as extending over the whole of creation, is that any manipulation of the creation by mankind becomes subject to ethical question. Additionally, mankind's inclination to assign value to creatures as they become, or cease to be, useful to him is similarly regarded as ethically questionable in this theological construct. Here, the realm of God's sovereignty is viewed as God's own, as opposed to the more commonplace view that the realm is '... an entity or a process set alongside God'.[26] It is, as Baer has asserted, both 'as a whole and in each of its parts, His'.[27] As such, the entire creation is seen as possessing a God-given integrity and wholeness:

> '... Creation as understood in the Biblical tradition involves wholeness and interrelationship, not incidently, but fundamentally and necessarily ... Thus, wantonly to destroy/

24. Joseph Sittler, Essays on Nature and Grace (Fortress Press, Philadelphia, 1972), p. 116.

25. Santmire, op.cit., p. 116.

26. Ibid., p. 24.

27. Baer, op.cit., p. 46.

> destroy the relational and holistic qualities of our environment is to sin against the very structure of the world which God has created.' 28

> 'From the Biblical point of view nature has its own integrity in the eyes of God, a value and a meaning not exhausted by what it does and signifies for man.' 29

> 'In the first chapter of Genesis we are told repeatedly that God looked at what He had made and saw that it was good, very good, and this long before man appeared in the scene. Whatever is, is good, and it is good because it is.' 30

> 'Man and the rest of the world are jointly God's creatures. As created they have a value derived from their Creator ... all God's creatures are valuable to God and, hence, in themselves.' 31

The final major element of Christian environmentalism has to do with the recognition of mankind's creatureliness, and of his responsibilities to the created realm. In fact, it appears that the strength and validity of the theological insistence that the creation possesses inviolable integrity and goodness, and that God's absolute sovereignty extends to all aspects of the created realm, stem, in part, from the realisation of how destructive man can be when he dethrones God and establishes himself as the overlord of objectified nature. In Christian environmentalism, both human and non-human dimensions of earthly existence are perceived as belonging to the community of created being, and man is understood as being ultimately a creature among creatures. God's creation of the world out of nothing is/

28. Ibid., p. 49.

29. Santmire, op.cit., p. 98.

30. Kenneth Cauthen, Christian Biopolitics (Abingdon Press, Nashville, 1971), p. 133.

31. John B. Cobb, Jr., Is it too late? (Bruce Press, Beverly Hills, 1972), p. 87.

is presented as separating the substance of God from that of the world. It is not seen as separating one creature from another, nor as sparing man from the desacralisation to which nature is subject. Man and the other creatures are perceived as being finite, fallable, and imperfect - only God is seen as being infinite, infallable, and perfect. Man is presented as being immediately dependent for his creaturely survival on the other creatures, as they are dependent on him, with all creatures being ultimately dependent on God's providence.

In this Christian theology of ecology, then, man is seen primarily as a creature among creatures. This is not to disregard his manifold differences from the other creatures, or his transcendence of various natural principles. Indeed, his very uniqueness is seen as giving man certain duties and responsibilities to the created realm which no other creature can take on. For example, no other creature is able to perceive the creation as a functioning whole, or is able to act out of consciously altruistic motives in relationships with others, or is able to be transformed through communications with God - seeing other creatures as God sees them, good and valuable. If man chooses to ignore these God-given capabilities, and instead continues to use his capacities for self-awareness, for historical perception, and for technological mastery to cut himself off from the rest of nature, Christian environmentalists fear that he will eventually succeed in building 'a pinball machine of a world'.[32]

Christian ecologists claim that the crisis of the environment is a direct result of man's refusal to take his proper place in the creation. If man continues to reject his responsibility for the environment, and/

32. Elder, op.cit., p. 102.

and instead allows himself to be led by arrogance and pride, the result is seen as a further '... absurd earth-destroying, life-mutilating, future-cancelling, and brutal attack upon the resources and life-supporting materials and processes of man's ancient place, the earth itself'.[33] Additionally, Christian environmentalism asserts that when man refuses to take his place in the creation, he damages not only the creation, but his humanity as well.

> 'For when man degrades his natural environment he ultimately degrades himself as well. He forgets how much a part of nature he really is and fails to see how deeply he wounds himself, both physically and spiritually, when he destroys the ecological integrity, the beauty and harmony of his natural environment.' [34]

Further, it is claimed that man's destruction of nature, consequent from his separation from it, means that man has lost the sense of God's presence in the whole of creation. He behaves as though God is the God of man alone, and not the God of all creation, and this, it is said is sin - 'sinful man relates himself to nature, in which he has life and throughout which God rules majestically as a predominantly godless reality'.[35] Elder states that because God is the God of the whole of creation, then man's violation of that creation constitutes conflict with God.[36] He goes on to add that the crisis of the environment is, therefore, a judgement: '... it can be said that man in his uninformed quest for dominance will finally meet God ... as the reality/

33. Sittler, op.cit., p. 70.

34. Richard Baer, 'The Church and Man's Relationship to his Natural Environment', <u>Quaker Life</u>, January 1970, p. 3.

35. Santmire, op.cit., p. 166.

36. Elder, op.cit., p. 102.

reality of the systems over which man seeks control, and in a wrathful expression of sovereignty'.[37]

Ethical Response to Nuclear Energy

While essential elements of the Christian environmental theology are yet to be worked out, the practical application of its basic premises has apparently been the working principle of the Churches' response to the dilemmas posed by nuclear energy. As David Pearce has pointed out, 'The nuclear debate is about values',[38] and the values at issue in the nuclear energy controversy are precisely those values to which Kenneth Boulding referred in the creation of his 'spaceship earth' ethic. Giles Ecclestone acknowledged the correlation between ecological and nuclear power ethical considerations when he stated that nuclear technology, '... raises major issues about the nature of our society, our responsibility for the future, and the risks we are entitled to take'.[39] Ecclestone continued that nuclear issues not only involve 'technical considerations, but also economic, social, environmental and political issues and the striking of a balance between them'.[40] The World Council of Churches has similarly emphasised the wider socio-ecological context of the nuclear energy/

37. Ibid., p. 131.

38. David Pearce, 'The Nuclear Debate is about Values', Nature, Vol. 274, July 20, 1978, p. 15.

39. Giles Ecclestone, 'Statement of Evidence by Mr. G.S. Ecclestone in support of the evidence of the British Council of Churches', (BCC, London, 1977), p. 1.

40. Ibid.

energy debate many times, concluding, at its most recent World Conference, that the nuclear situation '... highlights the inequalities between rich and poor both within and among countries, the depletion of resources at the cost of serious damage to the environment and the choice of options without adequate information'.[41]

As stated in the introduction to this section, the ethical issues surrounding nuclear energy technology essentially involve the morality of taking risks. In fact, in reference to the dilemmas posed by nuclear energy, Roger Shinn has called for the development of '... a theology of risk'.[42] Certainly, it is an almost unanimous consensus among the concerned Christian churches, or the churches and church groups cited in the 'Historical Survey' section of this chapter, that the development and utilisation of nuclear technology is risky. The churches have been rather unimpressed by the often cited defense of nuclear technology that risks and hazards are inherent in the use of any and all technology. Instead, they perceive the severity of the risks involved to be of an entirely different ethical plane. As stated by Elizabeth Dobson-Gray:

> 'The decisions about nuclear energy today are made in a whole new ethical space. We the public are in a new ball park, demanding new rules for the risk game because for the first time, we perceive that we are <u>all</u> in "the original position", all sharing equally and unknowingly in future risks whose extent and location will become known only gradually in the unfolding of/

41. World Council of Churches, 'Energy for the Future', <u>Reports from the World Conference on Faith, Science and the Future</u> (WCC, Geneva, 1979), p. 3.

42. Roger Shinn, 'Faith, Science, Ideology and the Nuclear Decision', <u>Christianity and Crisis</u>, vol. 39, February 5, 1979, p. 6.

unfolding of time ... We are all blindly and equally involved in nuclear energy risk.' [43]

The particularly hazardous risks frequently cited by churches and church groups involved in the nuclear energy debate, include the dangers of nuclear radiation to human and animal health, the risks of proliferation and nuclear terrorism, and the possible necessity to create a global police state to ensure the safe development and use of a world-wide nuclear programme. In regard to the dangers of atomic radiation to human and animal health, the churches have repeatedly emphasised the fact that even a small increase in the global level of radioactivity, which is an inevitable consequence of nuclear technology, will lead to an increase in cancer and genetic illnesses. For example, the BCC was quite adament in its closing statement at the Windscale Public Inquiry that '... the risk of physical damage to persons now alive and yet to be born, whether somatic or genetic, through radiation, should represent a consideration of major significance, and should take precedence over the objective of avoiding social or economic problems ...'[44] The correlative danger of a massive radiation leak caused by reactor breakdown or accident has also been presented by the churches as a very real hazard. There has been little ecumenical support for the argument that the chances of a major leak are so small as to be relatively inconsequential, particularly after the near catastrophe at Three Mile Island. The churches have also frequently cited the problem of long-term radioactive waste disposal as a major hazard in/

43. Elizabeth Dobson-Gray, 'Nuclear Risk: A Whole New Ethical Space', Christian Century, vol. 95, May 3, 1978, p. 486.

44. BCC, 'Closing Statement at the Windscale Public Local Inquiry', (BCC, London, 1977), paragraph 15.

in the nuclear fuel cycle. In this regard, the Flowers Report recommendation that 'There should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of a long-lived highly radioactive waste for the indefinite future',[45] has often been favourably quoted and adopted by ecumenical groups.

The issues of nuclear proliferation and nuclear terrorism have also been presented by the concerned churches as increasingly grave global dangers, particularly if nuclear energy technology continues to be developed and its use becomes even more widespread. The churches do not appear to have much faith in the ability of the Non-Proliferation Treaty to halt the spread of nuclear weapons, especially since India demonstrated a weapons potential in 1974. To many churches, the proliferation of nuclear weapons is perceived as inevitable, given the continued use of nuclear energy technology. In fact, some churches see this risk as the major drawback to nuclear power, and there seems to be an ecumenical consensus with the WCC demand '... that an immediate priority governing the widespread use and availability of civil nuclear technologies must be the introduction of more measures to reduce proliferation risks'.[46] Similarly, the churches perceive the risk of nuclear terrorism as becoming increasingly unacceptable with the further developments and use of nuclear technology. Again, the churches have endorsed the stand taken by the Flowers Report on this/

45. Sixth Report of the Royal Commission on Environmental Pollution, Nuclear Power and the Environment (HMSO, September 1976), p. 131.

46. WCC, 'The Energy Debate Continued', Anticipation, No. 26, June 1979, p. 43.

this issue: 'The spread of nuclear power will inevitably facilitate the spread of the ability to make nuclear weapons ... We see no reason to trust in the stability of any nation of any political persuasion for centuries ahead'.[47]

The final major hazard perceived by the concerned churches as being inherent in the nuclear energy option, is the possible creation of a police state as the only way to safely deal with the increasingly deleterious hazards of a global commitment to this type of energy production. As stated by the Catholic Truth Society, an inevitable outgrowth of the widespread use of nuclear technology will be the use of 'stringent security methods ... to ensure that every gram of plutonium is accounted for, to provide security for all plutonium sites, to guard plutonium that is being transported, and to take action in the event of a terrorist threat'.[48]

In their deliberations on, and assessments of, these various risks, the concerned churches have attempted to include the wider social and ecological issues involved. One point frequently made by the ecumenical groups in their discussions on nuclear energy, is that although technology exists to serve human needs, it can be used to destroy people and human values. The churches have acknowledged that this destruction can occur through either deliberate intent or unexpected consequences, and have generally rejected points of view that tend to separate goals and values from techniques and means.

47. 'Sixth Report of the Royal Commission on Environmental Pollution', op.cit., p. 76.

48. Catholic Truth Society, Nuclear Energy: a Christian Concern (Catholic Truth Society, London, 1977), p. 3.

In attempting to ethically evaluate the advances made by science and technology, Professor B. Barry has urged the development of a 'new ethic' which would, as a minimum, 'include the notion that those alive at any time are custodians rather than owners of the planet, and ought to pass it on in at least no worse shape than they found it'.[49] The churches have attempted to apply this notion, as well as the interconnectedness of the 'spaceship earth' concept, to the hazards posed by nuclear energy. As such, the churches have tended to attach considerable importance to the possibilities of satisfying global energy needs without the continued development and expansion of nuclear energy technology. It is felt that nuclear energy should be used only as a last resort to save the world from an energy shortage that would imperil human existence. The churches have been nearly unanimous in their belief that not only does such an energy shortage not now exist, but also that it is very doubtful that one will exist in the future. The churches have frequently cited the conclusions reached by Amory Lovins, Gerald Leach, and the Stobaugh-Yergin energy study group to suggest that the generally assumed energy consumption pattern, which underlie the argument for the rapid development of nuclear technology, are over-stated. In fact, as pointed out by the BCC in its closing statement at the Windscale Inquiry, a strong ethical case can be made for policy makers to base their energy strategies on an underestimation of energy needs. In making this point, the BCC noted that:

> 'The adoption of a figure higher than justified could lead to major misallocations of investment capital and a continuing burden to the consumer. Underestimation of energy needs, particularly if/

49. As quoted in David Gosling, 'The Morality of Nuclear Power', Theology, No. 679, January 1978, p. 30.

> if the gap were less than say 12 percent, would serve to provide strong incentives for individual and collective restraint and help to induce more responsible attitudes to energy resources.' 50

Two issues closely associated with future global energy requirements are the development of energy conservation measures and alternative energy sources. The concerned churches appear to be of a single mind in recommending that both of these issues need much more detailed investigation before a commitment to nuclear energy is morally justifiable. As recommended by the WCC: 'We make a strong plea for a major shift towards the development of an effective implementation of the huge potentiality as yet untapped of the soft option'.[51] As discussed in Chapter One, this soft option emphasises the rapid development of small-scale, less capital-intensive, decentralised technologies, such as solar heating and biomass. The soft option also includes a major commitment to conservation techniques and technologies.

Another major concern of the churches involved in the nuclear energy debate, is the suitability of nuclear technology to meet the energy needs of the developing nations of the world. The churches have frequently pointed out that while the need for energy is currently, and will be for the foreseeable future, critical among the developing nations, nuclear technologies are built for the peculiar energy demands and sophisticated energy grid systems of the developed nations. In addition, the churches have expressed their dissatisfaction over the/

50. David Gosling, 'Closing Statement at the Windscale Public Local Inquiry', (BCC, London, 1977), paragraph 8.

51. World Council of Churches, 'Energy for the Future', op.cit., p. 10.

the historical trend of the wealthy nations using technology to subjugate the poor. Is the desire for technical imperialism at the base of the Western nations' eagerness to spread nuclear technology around the world? The BCC, in its assembly in the Spring of 1977, thinks it might be: 'The non-nuclear states, predominantly to be found among the nations of the Third World, are already closely tied to the economic fortunes of the developed world; to enter into arrangements such as have been suggested (concerning the importation of nuclear technology) would impose a still more complete dependence on Western technology and its products.'[52]

A final major concern of the churches regarding the continued development and use of nuclear energy is whether this form of energy production is actually cost-efficient. The churches seem to be in basic agreement that cost analyses which strip away government subsidies from the nuclear programme, and which factor in capital expenditures for eventual decommissioning and decontamination procedures, the mining of more inaccessible ore, and the energy costs required to build a reactor, need to be not only listened to, but deserve more adequate attention from the nuclear power industry. Clearly, from an ethical point of view, it would be morally indefensible to continue developing and using an energy option as hazardous as the nuclear one, if it cannot be irrefutably justified from at least an economic standpoint.

Consequently, the overwhelming consensus among the concerned churches is that: nuclear power is risky, it is not suited to the/

52. BCC, 'British Energy Policy and the Fast Breeder Reactor', (BCC, London, 1977), paragraph 17.

the energy needs of the developing Third World, and it may not even be necessary to meet the energy needs of the developed First and Second Worlds. In addition, the churches generally feel that a commitment to nuclear energy would entail an inevitable commitment to a centralised and authoritarian decision-making process, as well as to the necessity of an indefinite era of peace. Thus, at the bottom line of any ethical discussion regarding the development and use of nuclear energy, lies the perceived morality of risk-taking. The near unanimous consensus of the concerned churches to date is that the risks inherent in nuclear technology do not justify its continued development and expanded use at the current global rate. As previously discussed in the 'Historical Survey' section of this chapter, most of the church groups cited have recommended at least a slowing in the development of nuclear technologies, with two major groups calling for an immediate moratorium on the further development of the nuclear option. While the churches have uncovered no clear-cut moral principle which can be used to determine the rightness or wrongness of nuclear energy decisions, they have raised a number of important moral considerations, not only about nuclear technology, but also about the nature of technological development, the type of society that would be worthy to pass on to future generations, and the responsibility humanity has for the ecological well-being of the planet.

The concerned churches, then, are in ultimate agreement with the conclusion reached by the Flowers Report: 'We should not rely for energy supply on a process that produces such a hazardous substance as plutonium unless there is no reasonable alternative'.[53]

53. 'Sixth Report of the Royal Commission on Environmental Pollution', op.cit., p. 193.

In arriving at such a position, the churches have demonstrated David Gosling's assertion that:

> '... It may be said that although Christian theology seems currently unable to provide a framework, within which scientific and technological decisions can be evaluated, there is a more general tradition which considers such decisions from the point of view of whether or not they provide a context for true human development and within which a hierarchy of priorities can be established.' 54

54. Gosling, op.cit., p. 32.

CONCLUSION

It is the overwhelming ecumenical consensus that a present commitment to the development and use of advanced nuclear technology is unethical. In their responses to the nuclear energy debate, the concerned Christian churches have clearly reached the conclusion that the potential benefits to be derived from nuclear power do not now justify the attendant risks.

An essential component of any ecumenical stance involving man's relationship with the natural world, is a preconceived notion of stewardship and man's environmental responsibilities. While this notion tended to be anthropocentric in the recent Christian past - with considerable submission to the claims of mechanistic science, technology, and industry - it is currently being redefined in theocentric terms. Here, both humanity and nature are perceived as being grounded, unified, and authenticated in God. This concept is basically egalitarian in that all things, not just the human species, are seen as being led to a final fulfilment. Mankind's ecological responsibilities therefore, take on a corresponding broadening. 'Dominion' no longer infers limitless economic growth for the affluent few, but requires the curtailment of unlimited growth, the redistribution of wealth to all peoples, and the interdependence of all creatures. 'Stewardship' is concerned with the wholeness and unity of all created existence, and with mankind's responsibility to the world of nature, as its finite gardener, in co-operation with its infinite gardener. The basic environmental ethic, then, is one of respect for the interdependence and holistic qualities of nature/

nature - the 'garment of God'.[1]

Fundamental to the practical application of this sense of environmental responsibility and respect, is the determination whether specific actions will ultimately contribute or detract from the restoration, care, and maintenance of the planet. As Larry Ruff has pointed out, 'The choice facing a rational society is not between clean air and dirty air, or between clear water and polluted water, but rather between various levels of dirt and pollution. The aim must be to find that level of pollution abatement where the costs of further abatement begin to exceed the benefits.[2] This principle, which Ruff calls 'marginalism', has been applied to mankind's choice of enterprises by Gilbert Doan. Here the judgement of marginalism is made through the consideration of three major aspects: 'whether the enterprise makes economically rational demands ... whether its own internal economy is marginally efficient ... and whether the enterprise is marginally rational'.[3] In other words, the major concern underlying the development of any enterprise or technology is whether the society, in its ecological setting, really and rationally needs it. From this analytical perspective, the churches are agreed that a commitment to nuclear energy becomes irrational.

An adjunct issue to the recent ecumenical involvement in the ecological problem in general, and the dilemmas of nuclear energy in/

1. H. Paul Santmire, 'Reflections On the Alleged Ecological Bankruptcy of Western Theology', Anglican Theological Review, vol. 57, No. 2, April 1975, p. 151.

2. Larry Ruff, 'The Economic Common Sense of Pollution', The Public Interest, No. 19, Spring 1970, p. 71.

3. Gilbert E. Doan, Jr., 'Toward a Life Style Environmentally Informed', Lutheran Quarterly, vol. 23, 1971, pp. 313-314.

in particular, is the question of the churches' motivation. Do the contemporary church pronouncements stem from an established, deep-seated Christian conviction of ecological unity; or, are they merely religious window-dressings on the liberal environmental policies and beliefs as presented by such groups as Friends of the Earth and the Sierra Club? As should be obvious from a comparative reading of Chapters One and Three, the churches' stance on nuclear energy now lies somewhere between the case put forth by the advocates of the 'soft energy path', and that advanced by the supporters of the 'hard-soft' option. The motivation behind this stance becomes somewhat open to question when the timing of the churches' entry into the debate is acknowledged. Are the churches acting independently, and from a leadership perspective; or are they following the lead of the environmentalists?

Certainly, the public environmental protection campaign, which began in the 1960s and gained a widespread following in the 1970s, did stimulate church involvement to a certain degree. In fact, according to Paul Abrecht, it was precisely at the point when this campaign succeeded in eroding extensive public confidence in 'the existing institutions for maintaining and securing the nuclear fuel cycle', that the churches '... began their first tentative entry into the debate'.[4] This does not necessarily mean that the churches have been simply parroting the established liberal ecological line. It could well be that the environmental protection movement has given the Christian churches a necessary inspiration to rediscover or/

4. Paul Abrecht, 'The Churches and the Nuclear Energy Debate', Ecumenical Review, July 1978, p. 222.

or re-emphasise an ecological tradition that has long been ignored. At least, this is the allegation of the Christian environmentalists. It appears to be generally accepted by the Christian environmental school that Christianity's ecological dimension had become perverted and was subsequently effaced by the Western churches with the institutionalisation of Immanuel Kant's industrial-mechanical view of nature. In fact, according to H. Paul Santmire:

> 'Fatefully, Immanuel Kant was typical of his time when he took it for granted that natural science had reached its apex in Newton's work. Kant held, as a matter of course, that objective empiracle judgements could not be incompatible with the principles of Newton's physics ... like Newton, Kant believed that nature is composed of immutable, hard, and dead conglomerations of moving particles. Although in a certain sense ... it is proper to say that Kant "relativised" the mechanical view of nature ... he nevertheless took over the major features of the view bequeathed him by Newton.' [5]

A corollary of this view, is that by accepting and affirming the mechanical picture of nature, Kant was led to ultimately separate the ideas of God and nature, 'For Kant', Santmire writes, 'nature remains a self-subsisting whole'.[6] This notion, it is claimed, was strongly buttressed by the rising socio-economic pressures of the contemporary, rapidly developing industrial society, and became a compelling philosophical foundation for many ensuing Protestant theologians. From this perspective, subsequent Christian theologies are perceived to have basically accepted the Kantian industrial-mechanical view of nature. This development, plus a heavy influence coming from the/

5. Santmire, op.cit., pp. 136-137.

6. Santmire, op.cit., p. 137.

the socio-economic forces of modern industrial society, is said to have forced Western Christian beliefs to become more and more a theology of God and humanity apart from nature. From Kant to Barth, this 'the-anthropological' theology is perceived to have gained ascendency within mainstream Protestant thought.

Several Christian historians place the beginnings of Christian anthropocentrism even earlier than Kant. Frederick Copleston, for example, claims that the Aquinian synthesis of Greek philosophy and Christian beliefs, founded on the principle of the separation of subject and object, ultimately resulted in a perceived theological detachment of humans from the natural environment. However, regardless of the precise historical development of Christian anthropocentrism, it is generally agreed by modern Christian writers that this development was a major departure from the early Christian ecological tradition.

It has been well demonstrated by Christian environmentalists who have attempted to outline this early Christian ecological tradition, that a strong Biblical case can be made for theocentrism and an ecological view of the world that is holistic (see 'Christian Responsibility' in Chapter Two, and 'A Theology of Ecology' in Chapter Three). Yet the question remains, is this a true interpretation of Biblical scripture; or a selective appropriation of Biblical text? A major problem in answering this question is the varied importance ascribed to nature in the Old and New Testaments. While the Old Testament is replete with numerous references to man's relationship to the created realm, the New Testament is generally silent on the subject. Reasons given for this disparity include differing sociological settings - where the Old Testament writers are/

are said to have been predominantly agricultural and rural, and the New Testament writers more urbanised -; differing intents - with the Old Testament seen as a vast source book, and the New Testament more a gospel of personal salvation -; and differing eschatological expectations for the natural realm - with Old Testament writers assured of the permanency of the entire creation, and the early Christians certain that the created order would soon pass away.[7] Additionally, it is generally recognised that for the Christians for the first century, the Old Testament was their Bible. It, and it alone, stood as the inspired world of God. It can be reasoned, therefore, that those elements of Judaism which were supported and adopted by the early Christians, would simply have been omitted from the Christian writings. Thus, perhaps, the ultimate question, on the subject of Biblical ecology, becomes: what is the proper God-man-nature relationship from the Old Testament perspective? While this question may have no simple answer, it seems to be clear that both social and natural estrangements were accorded equal weight in the Hebraic interpretation of a broken order of creation.

> 'Behold, the Lord will lay waste the earth and make it desolate,
> And he will twist its surface and scatter its inhabitants ...
>
> The earth shall be utterly laid waste and utterly despoiled; ...
> The earth mourns and withers; ...
> The earth lies polluted under its inhabitants; for they have transgressed the laws, violated the statutes, broken the everlasting covenant.
> Therefore/

7. For a more detailed discussion of this issue see: John A. Baker, 'Biblical Atitudes to Nature', in Hugh Montefiore, ed., Man and Nature (Collins, Sons and Co., Ltd., London, 1975), pp. 87-109.

> Therefore a curse devours the earth, and its
> inhabitants suffer for their guilt; ...
> The city of chaos is broken down, every house
> is shut up so that none can enter ...
> Desolation is left in the city, the gates are
> battered into ruins.'
>
> (Isaiah 24:1, 3, 4-5, 10, 12)

Furthermore, the Old Testament presents proper man-nature relationships as a function of proper man-man and man-God relationships. For example, the Peaceable Kingdom is described as a universal cessation of hostilities - with the wolf dwelling with the lamb, the leopard lying down with the kid, and the little child leading them all.

> 'They shall not hurt nor destroy in all my Holy
> Mountain,
> for the earth shall be full of the knowledge of
> the Lord ...'
>
> (Isaiah 11:9)

Nature is intimately connected to the reconciliation of God's Kingdom.

> 'The wilderness and the dry land shall be glad,
> the desert shall rejoice and blossom;
> Like the crocus it shall blossom abundantly,
> and rejoice with joy and singing.'
>
> (Isaiah 35:1-2)

> 'The tree bears its fruit, the fig trees and
> vine give their full yield ...
> Rejoice in the Lord, for he has given early rain
> ... the threshing floors shall be full of grain,
> the vats shall overflow with wine and oil.'
>
> (Joel 2:22-24)

> 'Behold the days are coming, says the Lord,
> when the plowman will overtake the reaper and
> the treader of grapes ... the mountains shall
> drip sweet wine, and all the hills shall flow
> with it.'
>
> (Amos 9:13)

The Hebraic understanding of nature, therefore, appears to reveal a profound vision of eco-justice, where man and nature are/

are inextricably bound; - nature being continuously caught up in man's web of good and evil. Mankind's capacity to further ecological harm is portrayed as being deeply related to his ability and willingness to create a just, sustainable, and peaceful social order.

Consequently, it appears that there is indeed a Biblical tradition of theocentrism. Perhaps by restoring the principles of this ecological tradition, the Christian churches will also discover a broader meaning for ecological concern in Christ's interaction with his world. As stated by Joseph Sittler, Christ's response to his 'environment' could very well provide today's world the clue and the power that will lead to the understanding and care of our own.

> 'His environment was the "Father who sent me";
> His environment was the company of the poor, the despised, the "little ones" who have no power;
> His environment was the future of man in this world, in all man's transactions with this ecological world.
> And therefore, in Him is "forgiveness of sins, life and salvation" here, now, and always.' 8

8. Joseph A. Sittler, Jr., 'The New Creation', in Franklin Jensen and Cedric Tilberg, eds., The Human Crisis in Ecology (Lutheran Church in America, New York, 1972), p. 103.

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